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Ozone Source Apportionment Modeling for New Mexico Environmental Department –2022 and 2032 Ozone Source Apportionment Modeling using a CAMx 2022v2 12/4 km Modeling Platform – Draft

RAMBOLL

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EXECUTIVE SUMMARY

In 2025–2026, the New Mexico Environment Department (NMED) contracted with Ramboll to conduct a Regional Ozone Source Apportionment Study. The study was conducted in two phases. Phase I was performed from April through June 2025 during Fiscal Year 2025 (FY2025). Phase I included 2022v1 base case and 2026v1 ozone source apportionment modeling using the EPA's 2022v1 12 km photochemical grid model (PGM) platform based on the Comprehensive Air-quality Model with extensions (CAMx) (Ramboll, 2025a and 2025b).

Under Phase II (FY2026) of the NMED study, Ramboll developed a Conceptual Model of ozone formation in New Mexico (Ramboll, 2026a) and a higher-resolution CAMx 2022v2 12/4 km modeling platform. The CAMx 2022v2 12/4 km platform 2022 base case was subjected to a comprehensive model performance evaluation using concurrent 2022 surface ozone and NO_X observations and satellite data and special field study surface VOC and NO_X observations at Carlsbad Caverns for 2021 and at Loving, New Mexico (near Carlsbad City) for 2023 (Ramboll, 2026b). Phase II also conducted ozone source apportionment modeling for 2022 and 2032 using the CAMx 2022v2 12/4 km modeling platform.

This report documents the Phase II CAMx 2022 and 2032 ozone source apportionment modeling using the CAMx 2022v2 12/4 km modeling platform.

Permian Basin Ozone Concentrations

Figure ES-1 displays the ozone monitoring sites in the New Mexico 4 km modeling domain and the trends in ozone design values (DVs) between 2005 to 2025 at the three ozone monitoring sites located in the New Mexico portion of the Permian Basin in southeastern New Mexico: Carlsbad City and Carlsbad Caverns in Eddy County, and Hobbs in Lea County. In August 2018, U.S. EPA designated ozone nonattainment areas for the 70 ppb 2015 ozone National Ambient Air Quality Standard (NAAQS) based on observed 2014–2016 ozone DVs, which at the Carlsbad City and Hobbs monitoring sites were 67 ppb and 66 ppb, respectively. This resulted in Eddy and Lea Counties being designated as attainment areas under the 2015 ozone NAAQS. Since 2017, ozone concentrations in the Permian Basin have increased, coincident with increases in oil and gas (O&G) production in the region (Ramboll, 2026a). By 2018, maximum ozone DVs in the Permian Basin began and continue to exceed the 2015 ozone NAAQS (Figure ES-1, right panel).

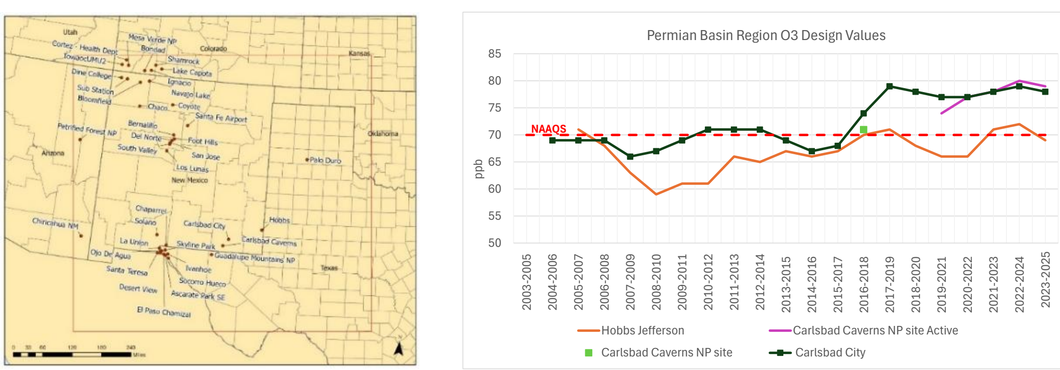

Figure ES-1. Locations of ozone monitoring sites within the New Mexico 4 km modeling domain (left) and 2005 to 2025 trends in observed ozone Design Values at monitoring sites within the New Mexico portion of the Permian Basin (right).

Development of a CAMx 2022v2 12/4 km Modeling Platform

A CAMx 2022v2 12/4 km modeling platform was developed for the summer 2022 (May-through mid-October) modeling period (Ramboll, 2026b). The 12 km grid resolution domain covered the continental U.S. (CONUS; 12US2 domain) and the 4 km grid resolution domain included New Mexico and portions of adjacent states, including all of the Permian Basin in Texas (Figure ES-1, left panel). Meteorological inputs for the CAMx 2022v2 12/4 km platform were based on a 2022 simulation of the Weather Research and Forecasting (WRF) meteorological model (Ramboll, 2025c). Boundary conditions (BCs) for the lateral boundaries of the 12 km CONUS domain were based on output from a CAMx 2022v2 North American 36 km domain simulation, whose BCs were based on a 2022 simulation of the Hemispheric CMAQ (HCMAQ) chemistry model. Emissions for the CAMx 2022v2 12/4 km platform were based on the National Emissions Collaborative (NEC) 2022v2 Emissions Modeling Platform (EMP; EPA 2025b). EPA processed the 2022v2 inventories to generate PGM model-ready emission inputs for the 12 km CONUS domain that were used directly in the NMED CAMx 2022v2 12/4 km modeling platform. The EMP 2022v2 emissions were processed using the Sparse Matrix Operator Kernal Emissions (SMOKE) model to generate 2022 hourly gridded speciated CAMx emissions inputs for the 4 km New Mexico domain and the summer of 2022.

Evaluation of the CAMx 2022v2 12/4 km Platform 2022 Base Case Simulation

The CAMx 2022v2 12/4 km base case simulation results were evaluated against concurrent surface ozone and NO_X observations and satellite data, and special field study ozone precursor (VOC and NO_X) surface measurements collected at Carlsbad Cavern National Park in 2021 and Loving, New Mexico (LNM) near Carlsbad City in 2023. Ozone performance achieved or nearly achieved ozone Performance Criteria at all sites in New Mexico and achieved the ozone Performance Goals at approximately half the New Mexico sites. MDA8 ozone is generally underpredicted with some of the largest underpredictions occurring at sites in Eddy County in the Permian Basin. The evaluation of the CAMx 2022v2 12/4 km base case for VOCs at the Carlsbad Caverns and LNM sites in the Permian Basin found that ethane and propane, two VOC species associated with oil and gas (O&G) production, were underestimated by approximately a factor of 5 at both sites. There are numerous instances of known missing O&G emissions in the Permian Basin and likely unknown missing O&G emissions as well. Several CAMx sensitivity tests were performed for a 20-day episode of the summer 2022 modeling period, including one that increased O&G NO_X and VOC emissions by a factor of 3 in the New Mexico portion of the Permian Basin that greatly improved ozone and VOC model performance. Details on the CAMx model performance are contained in the CAMx 2022v2 12/4 km 2022 base case modeling and model performance evaluation report (Ramboll, 2026b).

Development of 2032 Oil and Gas Emissions for the New Mexico 4 km Domain

The EPA 2022v2 O&G emissions inventory for the New Mexico 4 km domain was projected to 2032 accounting for growth and on-the books (OTB) control programs using a similar approach EPA used to project 2026 emissions in the 2022v1 EMP (EPA, 2025a). This included using the same OTB controls as used by EPA for their 2022v1 EMP 2026 projections that does not include some of the latest changes in regulations (e.g., April 2026 reconsideration of OOOOb/c controls[1]) and potentially other changes in the O&G regulatory

[1] https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/2026-final-rule-reduce-burden-oil-and

control program. Historical actual production data for oil and natural gas production were used to develop growth factors from year 2022 to 2025, and Energy Information Administration (EIA) 2025 Annual Energy Outlook (AEO2025)[2] forecasts were used to project emissions from 2025 to 2032. For the New Mexico portion of the Permian Basin (e.g., Eddy and Lea Counties), there are larger 2022 to 2032 O&G growth factors (e.g., 1.34 growth factor for oil production in Eddy County) than in the Texas portion of the Permian Basin, some of which show decline (e.g., 0.92 growth factor for oil production). Following the approach in EPA's 2022v1 EMP 2026v1 emissions projections, emission control estimates were based on the suite of regulations that were "on-the-books" at the time the EPA 2026v1 future year emissions inventory was developed (May 2025). Similar to the approach applied in the 2022v1 modeling platform 2026 future year emission inventories, no controls were applied to exploration emissions. Figure ES-2 displays the distribution of New Mexico 2032 O&G emissions in the Permian Basin by source type. The three largest sources of NO_X emissions in the New Mexico Permian Basin that comprise approximately three quarters of the NO_X emissions are artificial lift engines (35%), point engines and turbines (26%), and drill rigs (14%). Nonpoint tanks comprise a majority (54%) of the VOC emissions, with lesser contributions from several source categories such as artificial lift engines, point flaring, and associated gas venting.

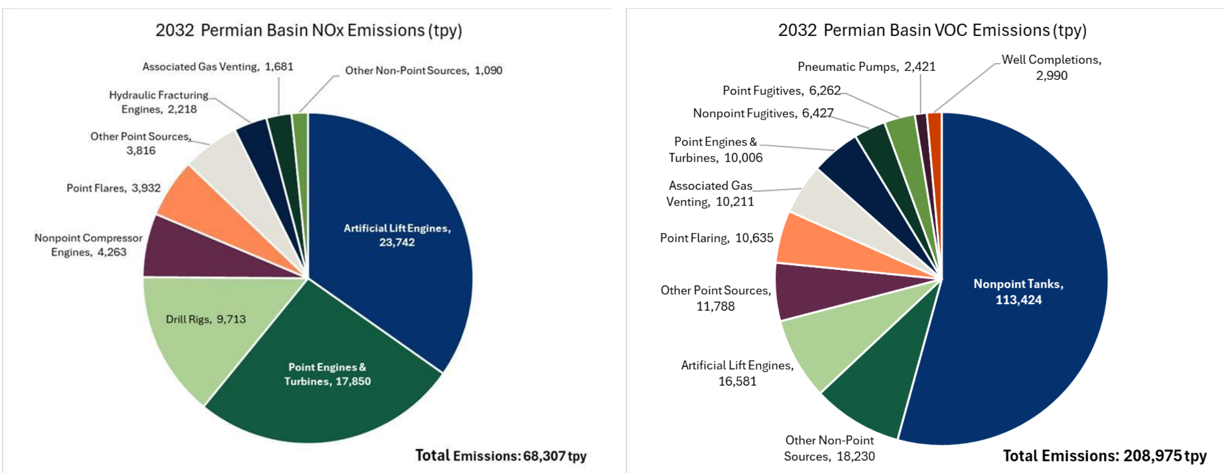

Figure ES-2. 2032 Oil and Gas NO_X (left) and VOC (right) emissions for the New Mexico portion of the Permian Basin.

Development of 2032 Emissions for the CAMx 2022v2 12/4 km Modeling Platform

The 2032 emissions for the NMED CAMx 2022v2 12/4 modeling platform were based on EPA's 2022v2[3] and 2022v1[4] Emissions Modeling Platforms (EMPs)[5] developed by the National Emissions Collaborative (NEC). Both platforms are based on the 2020 National Emissions Inventory (NEI) with updates to better represent the year 2022 (EPA, 2023; EPA 2025a and 2025b). EPA generated CAMx-ready emissions for the 12 km CONUS domain for the 2022 and 2026 emission years and the 2022v1 EMP but only developed model-ready emissions for the 2022 base year in the 2022v2 EMP. The CAMx-ready 2022v1 2026 or

[2] Accessed online in June 2026 at https://www.eia.gov/outlooks/archive/aeo25/
[3] https://www.epa.gov/air-emissions-modeling/2022v2-emissions-modeling-platform
[4] https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform
[5] https://www.epa.gov/air-emissions-modeling/2022v2-emissions-modeling-platform

2022v2 2022 12 km emission inputs were adjusted to the 2032 emissions year and used for the NMED 2032 CAMx 12 km CONUS domain emission inputs.

For the New Mexico 4 km domain, the 2022v1 and 2022v2 EMPs served as the foundation for the 2032 emissions with source sector emissions projected to 2032 several different ways and processed using the Sparse Matrix Operator Kernel Emissions v5.0 (SMOKE) modeling system to generate model-ready 2032 emissions for the New Mexico 4 km domain. The on-road and non-road mobile 2022v2 emissions were projected to 2032 using MOVES5 pollutant- and county-specific scaling factors. The EGU and non-EGU point sources from the 2026v1 inventory were used for 2032. And the procedures for projecting the 2032 O&G emissions are described above.

For both the 12 km CONUS and 4 km New Mexico domains, 2032 emissions for natural (e.g., biogenic, lightning NO_X and oceanic) and fires (wildfires, prescribed burns and agricultural burning) were held constant at 2022v2 levels.

Within New Mexico, the projected 2032 anthropogenic NO_X and VOC emissions are -9% and -23% lower than 2022v2 with the largest reductions coming from on-road mobile (-67% and -44%) and non-road mobile (-32% and -5%). New Mexico 2032 O&G NO_X emissions are projected to be +8% higher than 2022v2 while O&G VOC is reduced by -26%.

In the Texas portion of the Permian Basin, 2032 anthropogenic NO_X and VOC are projected to be -17% and -50% lower than 2022v2 driven mainly by lower on-road mobile (-61% and -38%) and non-road mobile (-32% and -7%). However, unlike the New Mexico portion of the Permian Basin where 2032 O&G NO_X emissions are projected to increase slightly (+8%), for the Texas portion of the Permian Basin, 2032 O&G NO_X (-11%) and VOC (-53%) are both projected to be reduced compared to 2022v2.

2032 Ozone Design Value Projections

Future year 2032 ozone Design Value (DVF_{2032}) projections were made following EPA guidance (EPA, 2018a) that recommends using PGM modeling results in a relative manner to scale the observed 2020-2024 base year ozone Design Value ($DVB_{2020\text{-}2024}$). The model derived scaling factors are called Relative Response Factors (RRF = PGM_{2032}/PGM_{2022}; Ozone DVF_{2032} = RRF x Ozone $DVB_{2020\text{-}2024}$). EPA has codified their recommended approach for making Design Value projection in the Software for the Modeled Attainment Test – Community Edition (SMAT-CE). SMAT-CE also has an Unmonitored Area Analysis (UAA) that interpolates the observed ozone $DVB_{2020\text{-}2024}$ across the domain and makes ozone DVF_{2032} projections for all of the domain.

Four different approaches were used to make future year ozone DVF_{2032} projections. Two of the projection methods use SMAT-CE using different days from the CAMx 2022 and 2032 modeling, one using CAMx results for the full modeling period of May 10 – October 15, 2022, and the other using CAMx results for just the June 10 – August 15, 2022 episode. The CAMx modeled ozone concentrations in May and early June 2022 are dominated by Boundary Conditions so the modeled ozone concentrations do not reflect changes in local emission. The other two ozone DVF_{2032} projection methods account for potentially missing O&G emissions in the Permian Basin by separately projecting the Local (i.e., ozone due to NM and TX Permian Basin O&G) and Non-Local components of the 2020-2024 ozone DVB using CAMx modeling results for the June 10 – August 15, 2022 episode.

Table ES-1 displays the projected ozone DVF_{2032} using the four projection methods. The ozone Design Values are colored red when they exceed the 75 ppb 2008 ozone NAAQS and colored yellow when they are between 75 ppb and the 70 ppb 2015 ozone NAAQS. The projected ozone DVF_{2032} using the first method using SMAT-CE with CAMx results for the full May – October 2022 modeling period is stiff, showing the least amount of reduction due to making projections using MDA8 ozone from days dominated by BCs; BCs remained unchanged between the CAMx 2022 and 2032 simulations. When using CAMx 2022 and 2032 results from the June 10 – August 15, 2022 period, similar projected 2032 ozone DVFs are obtained at the three Permian Basin sites whether using SMAT-CE or the two alternative methods. All methods project that Carlsbad City and Carlsbad Cavern will have projected 2032 ozone DVFs that exceed the 70 ppb ozone NAAQS with SMAT-CE using the full episode also projecting they will exceed the 75 ppb 2008 ozone NAAQS. The Desert View and La Union sites in southern Doña Ana County are also projected to have 2032 ozone DVFs that exceed the 2015 ozone NAAQS.

Table ES-1. Observed 2020-2024 ozone DVB and projected 2032 ozone DVF (ppb) using four projections methods.

		Observed	SMAT Full Period	SMAT Episode Period	Alternative #1	Alternative #2
		2020-24	2032	2032	2032	2032
Name	Site ID	DVB	DVF	DVF	DVF	DVF
Carlsbad Caverns	350150010	78.3	77.0	75.1	75.3	75.3
Carlsbad City	350151005	78.0	76.4	74.3	74.1	74.0
Hobbs	350250008	69.7	68.3	65.9	65.9	65.9
La Union	350130008	76.0	73.3	71.4		
Chaparral	350130020	70.3	67.6	65.6		
Desert View	350130021	77.3	74.6	72.7		
Santa Teresa	350130022	73.5	70.7	68.5		
Solano	350130023	67.3	65.3	64.2		
Ivanhoe	481410029	64.3	62.0	61.7		
El Paso Chamizal	481410044	69.0	67.0	65.7		
Ascarate Park SE	481410055	70.0	68.4	66.9		
Socorro Hueco	481410057	71.7	69.6	68.4		
Skyline Park	481410058	70.3	67.6	65.8		
Del Norte	350010023	69.7	67.2	66.4		
South Valley	350010029	66.0	64.1	63.2		
Foot Hills	350011012	72.3	69.1	68.6		
Bloomfield	350450009	65.3	62.0	62.8		
Navajo Lake	350450018	69.3	65.5	66.0		
Sub Station	350451005	67.0	64.4	65.3		
Shamrock	80671004	64.0	61.2	60.9		
Ignacio	80677001	66.3	62.3	61.6		
Bondad	80677003	66.0	62.7	61.3		
Cortez	80830006	62.3	60.9	61.1		

2022/2032 Local Source Ozone Source Apportionment Modeling

Local Source ozone source apportionment modeling was conducted for the 2022 and 2032 emission years using the CAMx 2022v2 12/4 km modeling platform. The CAMx 2022 and 2032 ozone source apportionment modeling used four Source Regions and ten Source Categories as given in Table ES-2. Since ozone contributions due to Initial Concentrations (IC) and Boundary Conditions (BC) always have to be tracked, this results in the CAMx 2022 and 2032 ozone source apportionment tracking the individual ozone contributions due to 42 Source Groups (42 = 4 x 10 + 2).

Table ES-2. Definition of the 10 Source Categories and 4 Source Regions that define the 42 Source Groups used in the CAMx 2022v2 12/4 Local Source ozone source apportionment modeling.

10 Source Categories		4 Source Regions	
Name	**Source Sectors**	**Name**	**Region**
NAT	Natural (Biogenic + LNOx)	NMPB	New Mexico Permian Basin
FIR	Fires	NMRE	Remainder New Mexico
OGD	Pre-Production Oil and Gas	TXPB	Texas Permian Basin
OGP	Production Oil and Gas	REMD	Remainder Domain
OGM	Midstream Oil and Gas		
EGU	Electrical Generating Units		
NEG	Non-EGU Point Source		
ONR	On-Road Mobile		
NON	Non-Road Mobile		
REA	Remainder Anthropogenic		

Figure ES-3 displays the SMAT-CE UAA 2020-2024 ozone DVF and projected 2032 ozone DVF across the New Mexico 4 km domain and the contributions of New Mexico anthropogenic emissions using the modeled ozone gradient adjusted interpolation procedure. The maximum 2020-2024 DVB (76.9 ppb) and 2032 DVF (77.7 ppb) occur in southern Eddy County. The SMAT UAA 2020-2024 ozone DVB exceeds the 2015 ozone NAAQS in the Permian Basin (both NM and TX) and the El Paso-Las Cruces ozone NAA and Juarez, Mexico. By 2032, the area that the ozone DVF exceeds the 2015 ozone NAAQS is limited to the New Mexico portion of the Permian Basin and a small area centered on the New Mexico portion of the El Pas-Las Cruces ozone NAA. The New Mexico anthropogenic emissions ozone contribution to the ozone DVB and DVF (Figure ES-3, bottom panels) is greatest in the Permian Basin, near Alburquerque, and in the Four Corners region with 2032 DVF being slightly lower than the 2020-2024 DVB, although they are more comparable in the Permian Basin (peak contributions of 12.7 and 12.5 ppb).

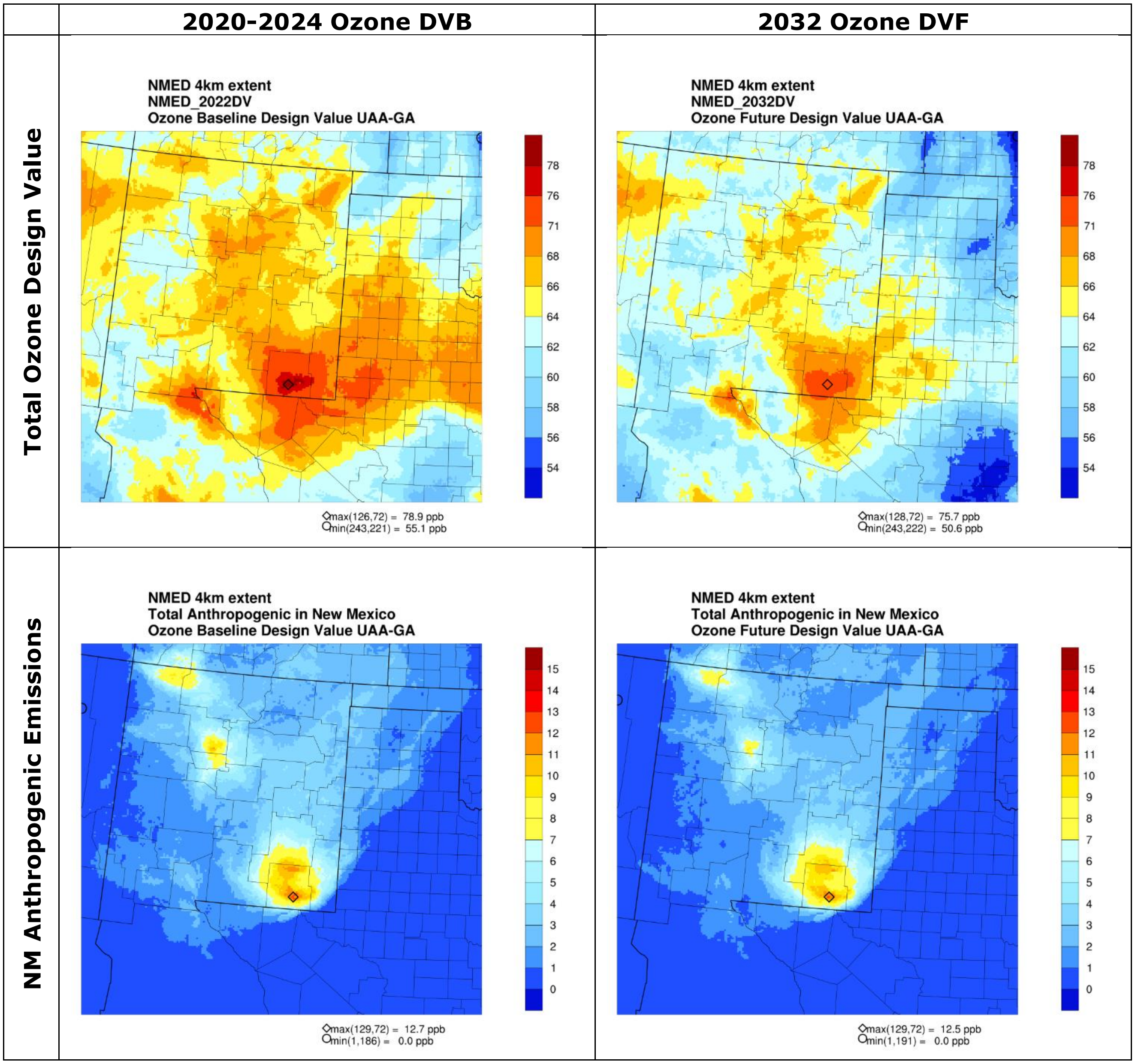

Figure ES-3. SMAT-CE UAA interpolated observed 2020-2024 ozone DVB (left) and projected 2032 ozone DVF (right) and the contributions of New Mexico anthropogenic emission to the Design Values across the New Mexico 4 km domain (bottom).

Figure ES-4 displays the contribution of New Mexico Permian Basin O&G emission to the 2020-2024 ozone DVB across the New Mexico 4 km domain. Of the 12.7 ppb maximum New Mexico anthropogenic emission contribution to the 2020-2024 DVB (Figure ES-3, bottom left), 12.4 ppb (98%) is due to O&G emission from the Permian Basin. NMPB Pre-Production (5.1 ppb) and Production (3.9 ppb) have maximum DVB contributions at the same southern Eddy County location as the NMPB total O&G peak, while Midstream O&G maximum contribution (5.7 ppb) occurs in northern Eddy County.

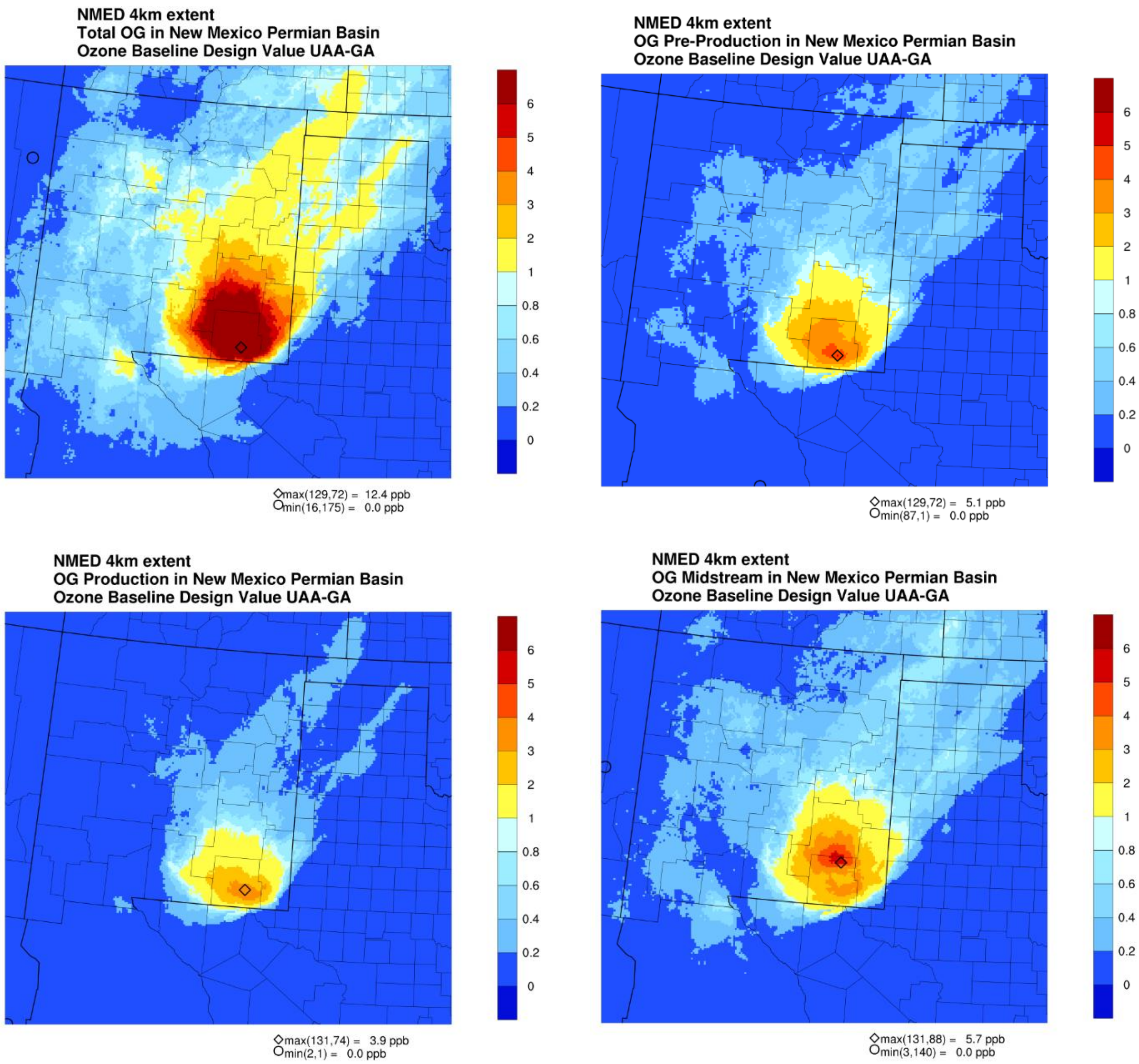

Figure ES-4. Contributions of New Mexico Permian Basin Oil and Gas emissions to 2020-2024 ozone DVB for all O&G (top left), Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

Table ES-3 displays the maximum contributions to the 2020-2024 DVB and 2032 DVF by Source Sector for the NMPB, Remainder NM, and TXPB Source Regions. The O&G source sector has the largest maximum contribution with little reductions seen between 2020-2024 and 2032, except in the TXB region (-14%). The on-road mobile has the next highest maximum contribution to the 2020-2024 DVB and it is reduced by a factor of 2 or greater in 2032.

Table ES-3. Maximum contributions to the 2020-2024 ozone DVB and projected 2032 ozone DVF (ppb) by Source Sector emissions from the New Mexico Permian Basin, Remainder New Mexico and Texas Permian Basin source regions.

Source	NM Permian Basin		Remainder NM		TX Permian Basin	
Sector Sector	2020 DVB	2032 DVF	2020 DVB	2032 DVF	2022 DVB	2032 DVF
Oil & Gas	12.4	12.3	7.5	7.4	7.7	6.6
On-Road	0.8	0.2	4.8	2.4	2.4	0.9
Non-Road	0.3	0.2	2.4	2.4	1.1	0.8
EGU Point	0.8	0.4	2.2	1.5	2.9	2.3
Non-EGU Pt	0.2	0.2	0.7	0.7	0.5	0.3
Non-Point	0.2	0.1	1.6	1.7	0.4	0.4

The CAMx 2022 and 2032 Local Source ozone source apportionment modeling results were extracted at the monitoring sites and loaded into Excel Dashboards so that the MDA8 ozone contributions can be explored for user-selected Source Categories, Source Regions and days. For example, Figure ES-5 displays the results from the 2022 and 2032 MDA8 Dashboards for Carlsbad City and all Source Regions and Source Groups for the 10 SMAT-CE days used to make 2032 ozone DVF projections. The 2032 MDA8 ozone concentrations tend to be slightly lower than 2022 with an average across the 10 SMAT days of 60.8 ppb compared to 63.8 ppb in 2022. This results in the percent BC contribution in 2032 (58%) being slightly higher than 2022 (54%) even though the magnitude of the BC contribution is nearly identical (34.6 ppb in 2022 versus 34.9 ppb in 2032) as the 12 km domain BCs remain unchanged between the 2022 and 2032 CAMx simulations.

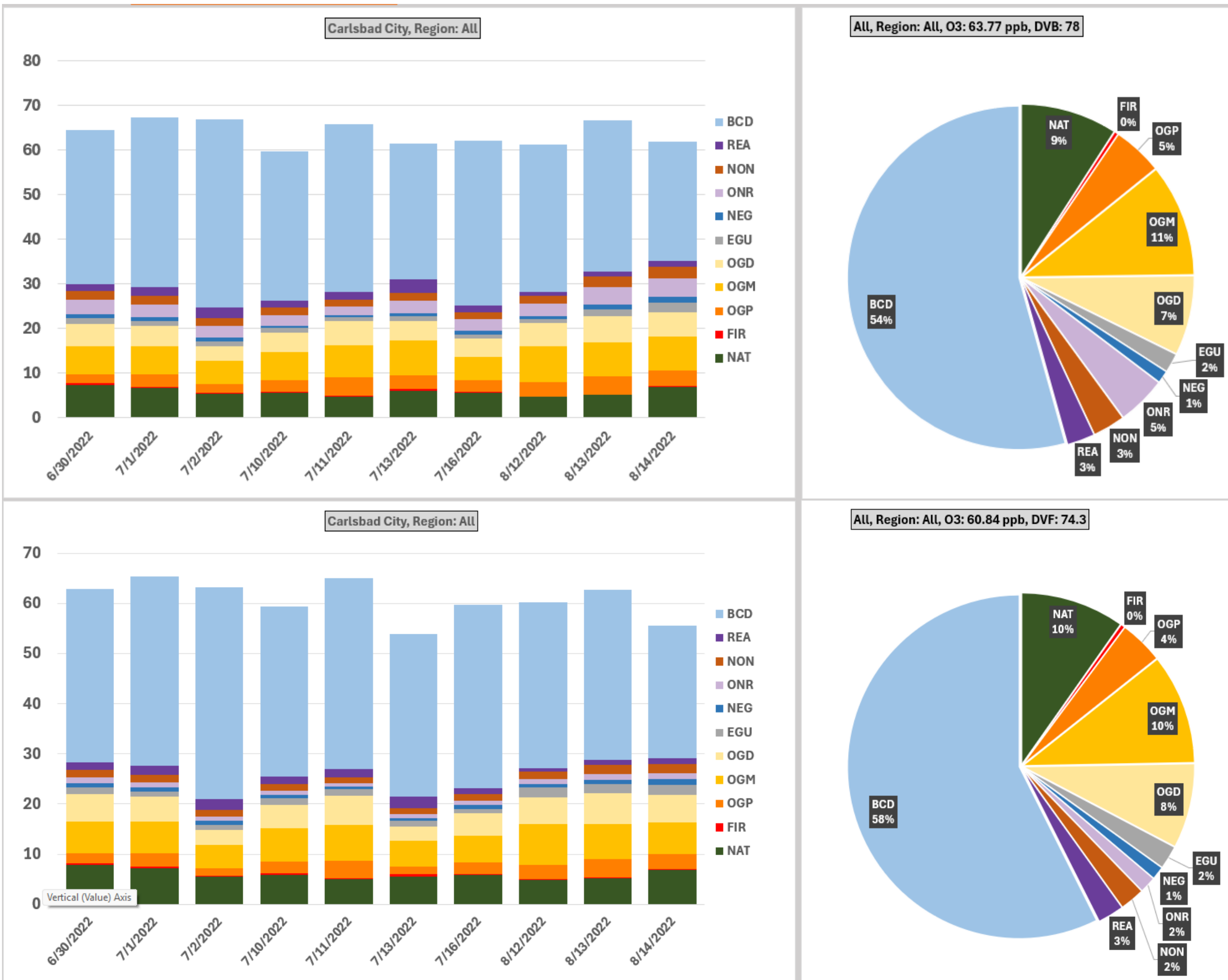

Figure ES-5. Carlsbad City 2022 (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

2022 State-Specific Ozone Source Apportionment Modeling

The 2032 State Specific ozone source apportionment simulation was run in a similar fashion that EPA uses for its transport rules (e.g., Good Neighbor Plan for the 2015 ozone NAAQS[6]). The State Specific ozone source apportionment modeling was run with 3 Source Categories and 11 Source Regions consisting of 9 western States, the portion of Mexico in the 12/4 km domain, and the remainder of the 12 km domain as shown in Table ES-4. Note that the original intent of the State Specific ozone source apportionment modeling was to also tag the BCs due to international anthropogenic emissions to obtain their contribution. Although EPA has performed a 2022 HCMAQ global chemistry model simulation with no international anthropogenic emissions, the results were not released in time for this study. The State Specific ozone source apportionment modeling was conducted for May 1 through August 15, 2022 period. EPA's Good Neighbor Plan used a 1% of the NAAQS (i.e., 0.70 ppb) significant contribution threshold.

[6] https://www.epa.gov/Cross-State-Air-Pollution/interstate-transport-2015-ozone-naaqs

Table ES-4. Definition of the 3 Source Categories and 11 Source Regions used in the CAMx 2022v2 12/4 State Specific ozone source apportionment modeling.

3 Source Categories		11 Source Regions	
Name	**Source Sectors**	**Name**	**Region**
BIO	Biogenic	AZ	Arizona
FIL	Fires plus LNOx	CA	California
ANT	Anthropogenic	CO	Colorado
		KS	Kansas
		NM	New Mexico
		NV	Nevada
		OK	Oklahoma
		TX	Texas
		UT	Utah
		MX	Mexico
		REM	Remainder 12 km domain

Figure ES-5 displays the contributions of the states and Mexico adjacent to New Mexico to the projected 2032 ozone DVF across the New Mexico 4 km domain. The maximum Arizona contribution is 2.5 ppb and occurs in Apache County, Arizona near the Springerville Generating Station. Arizona ozone contributions in excess of 1.0 ppb occur in western New Mexico counties. Arizona contributions exceeding 0.7 ppb (i.e., yellow or warmer colors) occur over most of the western half of New Mexico. The maximum contribution of Colorado to the projected 2032 ozone DVF in the New Mexico 4 km domain is 3.0 ppb and occurs in southern La Plata County, Colorado on the border with New Mexico. Surprisingly, the high Colorado contributions to 2032 ozone DVFs do not transport very far into New Mexico with contributions of above 1.0 ppb just barely getting into the northern parts of San Juan and Rio Arriba Counties in northern New Mexico. As seen in the CAMx 2022 and 2032 Local Source ozone source apportionment modeling discussed above, Texas has significant contributions to the projected 2032 ozone DVFs in Southern Doña Ana County and the Permian Basin portion of New Mexico. For just the anthropogenic emissions within the 12/4 domain, Mexico contributes over 1 ppb to the 2032 ozone DVF across the New Mexico portion of the Permian Basin and greater than 6 ppb in the ozone NAA portion in southern Doña Ana County. Although California has ozone contributions in excess of 0.70 ppb for scattered areas in the northwestern part of New Mexico, the ozone contributions of the other 4 states (KS, NV, OK and UT) were well below 0.70 ppb in New Mexico.

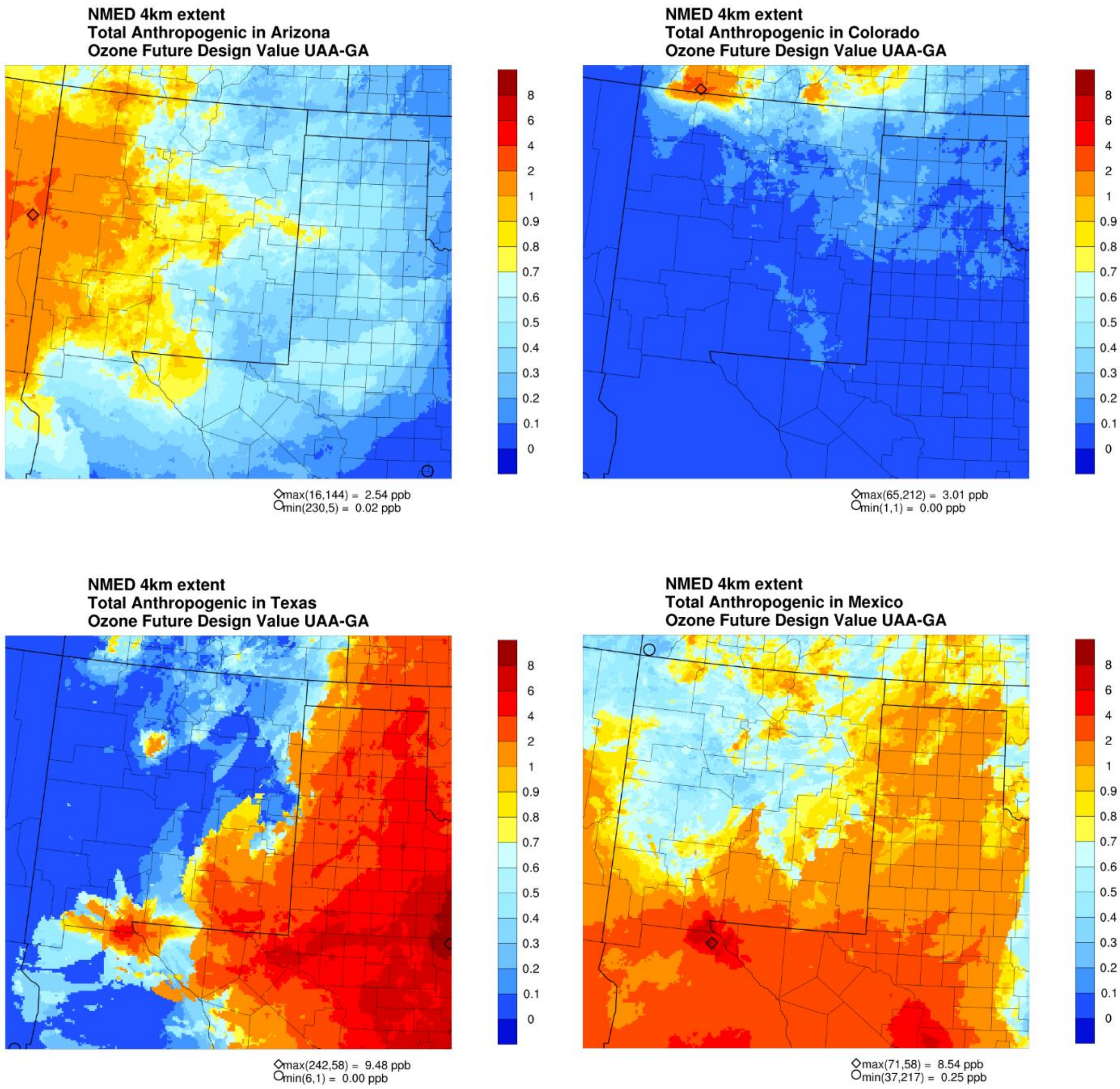

Figure ES-6. Contributions of anthropogenic emissions from Arizona (top left), Colorado (top right), Texas (bottom left) and the part of Mexico in the 12/4 domain (bottom right) to the projected 2032 ozone DVF in the New Mexico 4 km domain.

1.0 INTRODUCTION

In 2015, EPA promulgated a new 70 ppb ozone National Ambient Air Quality Standard (NAAQS). The ozone NAAQS uses an ozone Design Value (DV), defined as the three-year average of the fourth highest Maximum Daily Average 8-hour (MDA8) ozone concentration, as the metric for comparison with the 70 ppb threshold. EPA designated ozone nonattainment areas (NAA) under the 2015 ozone NAAQS on August 3, 2018 using the 2014-2016 ozone DVs.

1.1 Ozone Concentrations in the Permian Basin

The Permian Basin is currently the most active producing oil and gas (O&G) basin in the U.S. The Permian Basin includes southeast New Mexico (NM) and northwest Texas (TX). In New Mexico, most of the Permian Basin O&G production is within Eddy and Lea Counties. In 2022, three ozone monitoring sites were operating in Eddy and Lea Counties:

- Carlsbad Caverns (35-015-0010), 727 Carlsbad Caverns Highway, Eddy County.
- Carlsbad City (35-015-1005), 2811 Holland St., Carlsbad, Eddy County.
- Hobbs (35-25-0008), 2320 N. Jefferson St., Hobbs, Lea County.

Figure 1-1 displays the ozone DV trends at the three monitoring sites in Eddy and Lea Counties, New Mexico for the period of 2005 to 2025. The currently active Carlsbad Caverns monitor has been in operation since 2019 and did not report a 2014-2016 ozone DV that defined ozone NAAs under the 20925 ozone NAAQS. The Carlsbad City and Hobbs 2014-2016 ozone DVs were, respectively, 67 and 66 ppb, which were below the 70 ppb NAAQS resulting in Eddy and Lea Counties being designated as attainment areas under the 2015 ozone NAAQS. However, since then there has been increases in ozone in the Permian Basin with the Carlsbad City ozone DVs exceeding the 70 ppb 2015 NAAQS starting in 2018 and exceeding the 75 ppb 2008 ozone NAAQS since 2019. The most recent 2023-2025 ozone DVs at Carlsbad City and Carlsbad Caverns are, respectively, 78 and 79 ppb, so exceed both the 2008 and 2015 ozone NAAQS. The Hobbs 2023-2025 ozone DV is just below the 2015 ozone NAAQS (69 ppb), although the Hobbs 2022-2024 ozone DV was exceed the 2015 NAAQS (72 ppb).

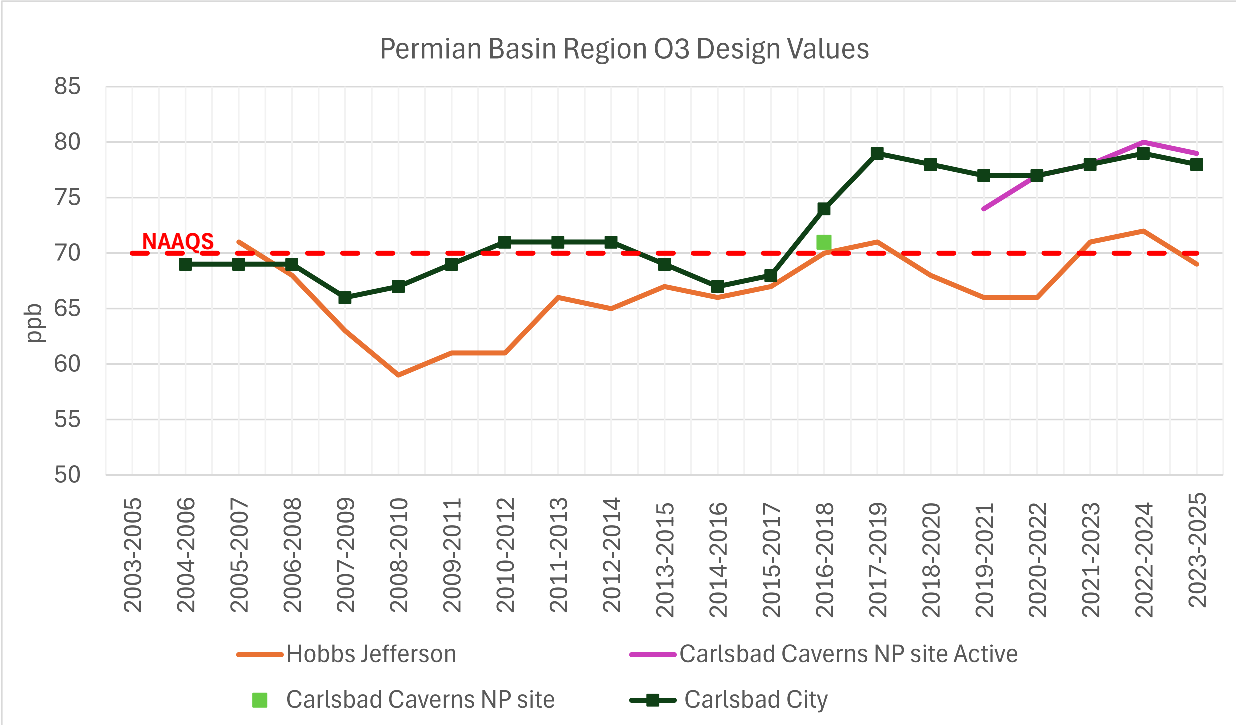

Figure 1-1. Ozone Design Value trends from 2005 to 2025 at the Carlsbad Caverns (350150010) and Carlsbad City (350151005) monitors in Eddy County and the Hobbs (350250008) monitor in Lea County.

1.2 Purpose

The New Mexico Environment Department (NMED) Air Quality Bureau (AQB) seeks to understand the causes of, and potential mitigation strategies for, elevated ozone concentrations within the New Mexico portion of the Permian Basin. To support this effort, NMED/AQB contracted with Ramboll to conduct ozone source apportionment modeling to estimate the contributions of emissions from New Mexico and other regions to ozone concentrations in New Mexico, with a particular focus on the contribution of oil and gas emissions to ozone levels in the New Mexico portion of the Permian Basin. This work was performed in two phases:

- Phase I (FY2025): The first phase was conducted between mid-April and June 30, 2025 used the Comprehensive Air-quality Model with extensions (CAMx; Ramboll, 2014) photochemical grid model (PGM) with the existing EPA CAMx 2022v1 12 km continental U.S. (CONUS) modeling platform. CAMx 12 km simulations were conducted for a 2022v1 base case and a 2026v1 future year, the latter invoking ozone source apportionment. Phase I also conducted summer 2022 4 km high resolution WRF meteorological modeling that was used to develop a higher resolution CAMx 2022 4 km modeling platform used in Phase II. Phase I produced several Excel Dashboards that display the contributions of emissions from Source Categories and Source Regions to MDA8 ozone concentrations at monitoring sites in New Mexico and adjacent regions and three main reports:
    - 2026 Ozone Source Apportionment Modeling for the Permian Basin using the 2022v1 Modeling Platform – 2022v1 Model Evaluation and 2026v1 Source Apportionment Results (Ramboll, 2025b).

    - WRF 2022 4 km Modeling for New Mexico and Model Performance Evaluation (Ramboll, 2025c).
    - Preliminary CAMx 2022 4 km Ozone Model Performance Evaluation Using New WRF 2022 4 km Meteorological Inputs (Ramboll, 2025d).
- Phase II (FY2026): Phase II started in July 2025 and ended June 30, 2026 and developed an enhanced CAMx summer 2022v2 12/4 km modeling platform with a higher resolution 4 km grid covering New Mexico and adjacent areas. Emissions for the CAMx 2022v2 12/4 km platform were based on EPA's 2022v2 emissions inventory. CAMx 2022v2 12/4 km modeling platform ozone source apportionment modeling was conducted using the 2022 and 2032 emission years. Phase II produced three reports:
    - Conceptual Model of Ozone Formation in New Mexico with a Focus on the Permian Basin (Ramboll, 2026a).
    - CAMx 2022v2 4 km Base Case Model Performance Evaluation (Ramboll, 2026b).
    - CAMx 2022/2032 Local-Source and 2032 State-Specific Ozone Source Apportionment Modeling using the NMED 2022v2 12/4 km Modeling Platform (this report).

1.3 Development of the CAMx 2022v2 12/4 km Modeling Platform

The following sections summarized the development of the CAMx 2022v2 12/4 km modeling platform with more details provided in Ramboll (2026b).

1.3.1 Episode Selection

The summer 2022 was selected for the NMED ozone source apportionment modeling due to the availability of 2022 emissions from the 2022v2 Emissions Modeling Platform (EMP), EPA's 2022v2 36/12 km modeling platform, and presence of elevated ozone concentrations in the Permian Basin. The CAMx 2022v2 12/4 km modeling platform was developed for the May 1 through October 15, 2022 period, with May 1-9 used as a spin-up period to initialize the model concentrations. Some of the sensitivity tests and source apportionment modeling were run for a portion of this modeling period.

1.3.2 Domain Selection

The NMED CAMx ozone source apportionment modeling used a 12/4 km two-way nested domain structure with the 12 km domain being the same 12US2 continental U.S. (CONUS) domain used in EPA's modeling platforms and in the Phase I CAMx 2022v1 12 km modeling. The 4 km grid resolution domain covered all of New Mexico and portions of adjacent states stretching far enough into west Texas to include all the Permian Basin O&G activity. Figure 1-2 displays the CAMx 12/4 km domains.

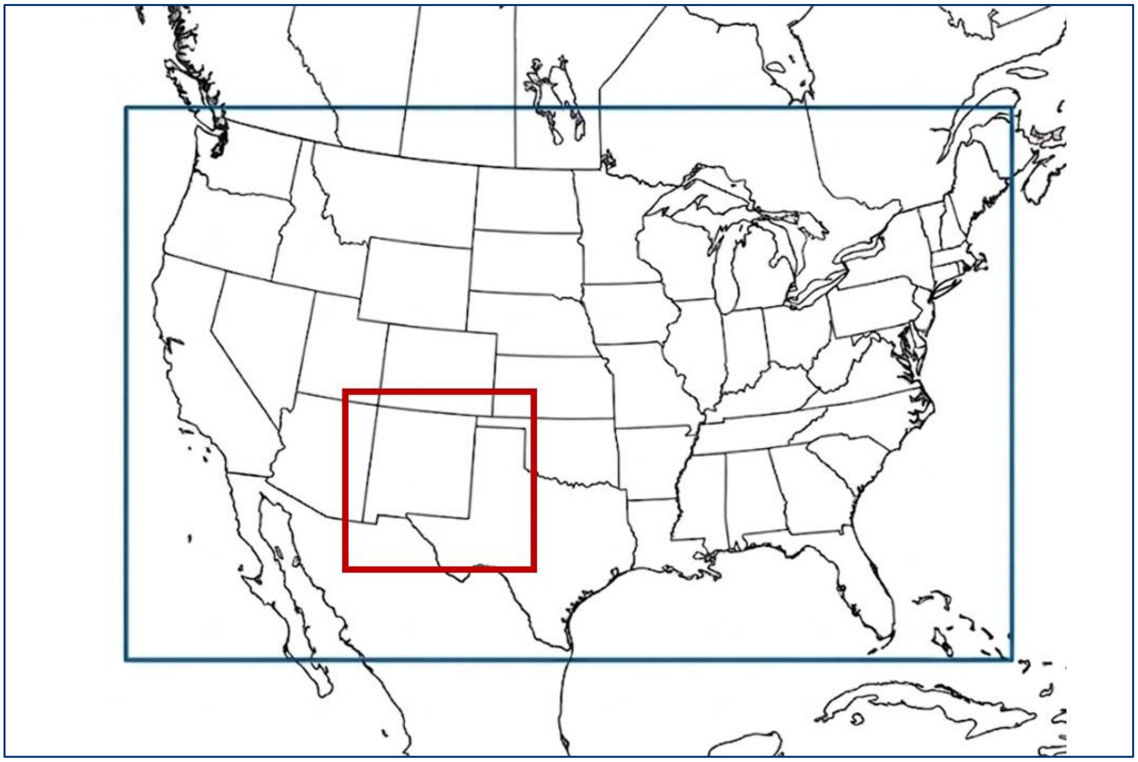

Figure 1-2. CAMx 12 km CONUS (blue) and 4 km New Mexico (red) modeling domains used in the CAMx 2022v2 12/4 km modeling platform.

1.3.3 2022v2 12/4 km Emission Inputs

The CAMx 2022v2 12/4 km modeling platform base case emissions were based on the National Emissions Collaborative (NEC) 2022v2 EMP. The 2022v2 EMP is documented in the 2022v2 emissions inventory technical support document (TSD; EPA, 2025b). EPA processed the 2022v2 EMP 2022 inventories to generate CAMx and CMAQ model-ready emission inputs for the 36 km North American (not shown) and 12 km CONUS domains (Figure 1-2). The 2022v2 model-ready emissions for the 36/12 km domains were downloaded via EPA's Open Data Program site and used in the Phase II CAMx 12/4 km modeling.

The 2022v2 emissions were processed using SMOKE to generate 2022 hourly gridded speciated CAMx emissions inputs for the New Mexico 4 km domain.

1.3.4 2022v2 12/4 km Meteorological Inputs

The WRF meteorological model was run for the summer of 2022 using 36/12/4 km nested domains. The WRF 2022 12/4 km output was processed to generate CAMx 12/4 km meteorological inputs. Details on the WRF 2022 12/4 meteorological modeling can be found in the WRF 2022 application/evaluation report (Ramboll, 2025c) with a summary in Chapter 2 of the CAMx 2022v2 12/4 platform development report (Ramboll, 2026b).

1.3.5 2022v2 Boundary Condition Inputs

A CAMx 2022v1 36 km simulation of a North American domain was performed using Boundary Conditions (BC) from a 2022 Hemispheric CMAQ (HCMAQ) simulation. The output from the CAMx 2022v1 36 km simulation was processed to provide BC inputs for the CAMx

2022v2 12/4 km modeling platform. The same BCs were used in the NMED Phase I CAMx 2022v1 12 km and Phase II CAMx 2022v2 12/4 km modeling platforms.

1.3.6 CAMx 2022v2 12/4 km Base Case Modeling

A CAMx 2022v2 12/4 km base case simulation was performed for the period of May 1 through October 15, 2022. An ozone model performance evaluation was conducted and found that the Phase II CAMx 2022v2 12/4 km ozone performance was degraded compared to the Phase I CAMx 2022v1 12 km simulation. The CAMx 2022v2 12/4 km simulation had a larger ozone underestimation bias than CAMx 2022v1 12 km simulation, especially at sites in the Permian Basin portion of New Mexico. The cause of the degradation of the ozone underestimation bias in the CAMx 2022v2 12/4 km simulation was mainly due to a decrease in the New Mexico 2022v2 Non-Point O&G NO_X emissions by 40% between the 2022v1 and 2022v2 emission inventories. The 2022v2 EITSD (EPA, 2025b) notes that an error was corrected in the O&G drill rig and fracking engine emissions that reduced their NO_X emissions by 74% between the 2022v1 and 2022v2 emission inventories, which is believed to be the cause of the larger ozone underestimation bias in the Phase II CAMx 2022v2 12/4 km simulation compared to the Phase I CAMx 2022v1 12 km simulation.

1.3.7 CAMx 2022v2 12/4 km Model Performance Evaluation

The CAMx 2022v2 12/4 km base case simulation results were evaluated against concurrent surface ozone and NO_X observations and satellite data, and special field study ozone precursor (VOC and NO_X) measurements collected at Carlsbad Cavern National Park in 2021 and Loving, New Mexico (LNM) near Carlsbad City in 2023. Figure 1-3 displays the locations of ozone monitoring sites and the CAMx 2022v2 12/4 km bas case Normalized Mean Bias (NMB) performance metric for Maximum Daily Average 8-hour ozone concentrations at each monitoring site. The NMB symbols are colored grey for when they achieve the bias Performance Goal (≤±5%) and colored green (underestimation) or yellow (overestimation) when they fall between the bias Performance Goal and Criterion (≤±15%). The NMB achieves or nearly achieves the bias Performance Criteria at all sites in the New Mexico 4 km domain and achieves the bias Performance Goal at approximately half the sites. MDA8 ozone is generally underpredicted with some of the largest underpredictions occurring at sites in Eddy County in the Permian Basin in southeast New Mexico where the Carlsbad City and Carlsbad Cavern sites had NMB performance metrics of, respectively, -14.6% and -15.7% that are at the bias Performance Criterion. The evaluation of the CAMx 2022v2 12/4 km base case for VOCs at the Carlsbad Caverns and LNM sites in the Permian Basin found that ethane and propane, two VOC species associated with oil and gas (O&G) production, were underestimated by approximately a factor of 5 at both sites. Several CAMx sensitivity tests were performed for a 20-day episode of the modeling period, including Sens5 that increased O&G NO_X and VOC emissions in the New Mexico portion of the Permian Basin by a factor of 3. Increasing the New Mexico O&G emissions buy a factor of 3 produced much better ethane and propane model performance at both sites, as shown in Figure 1-4 for the LNM site, and also improved the ozone performance with the NMB at Carlsbad City site that was right at the bias Performance Criteria (~-15%) in the CAMx 2022v2 12/4 km base case reduced to within the Performance Goal (-2.5%). Details on the CAMx 2022v2 12/4 km base case model performance and sensitivity modeling can be found in Ramboll (2026b).

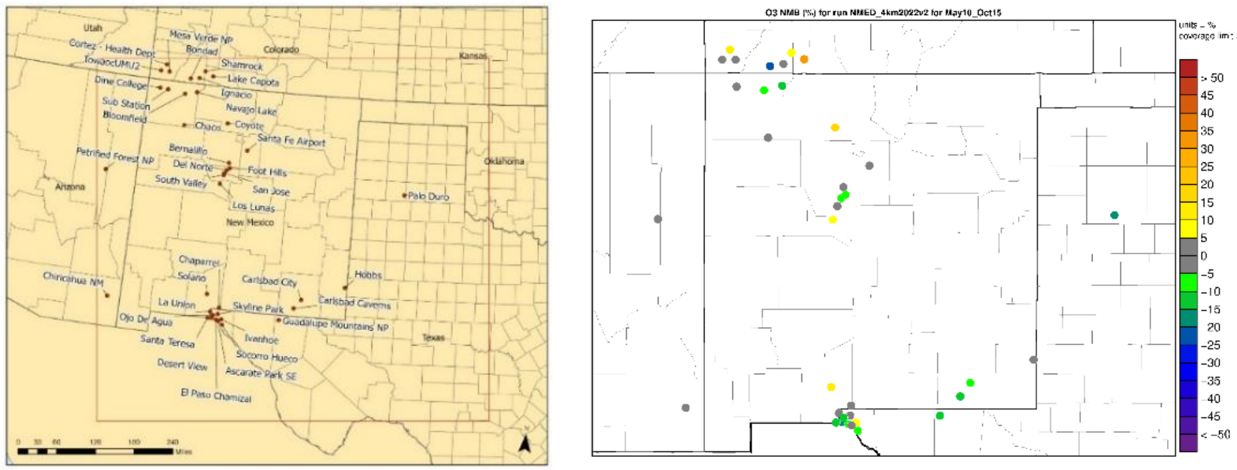

Figure 1-3. Locations of ozone monitoring sites within the New Mexico 4 km modeling domain (left) and Normalized Mean Bias (NMB) for MDA8 ozone concentrations at sites in the New Mexico 4 km domain (right).

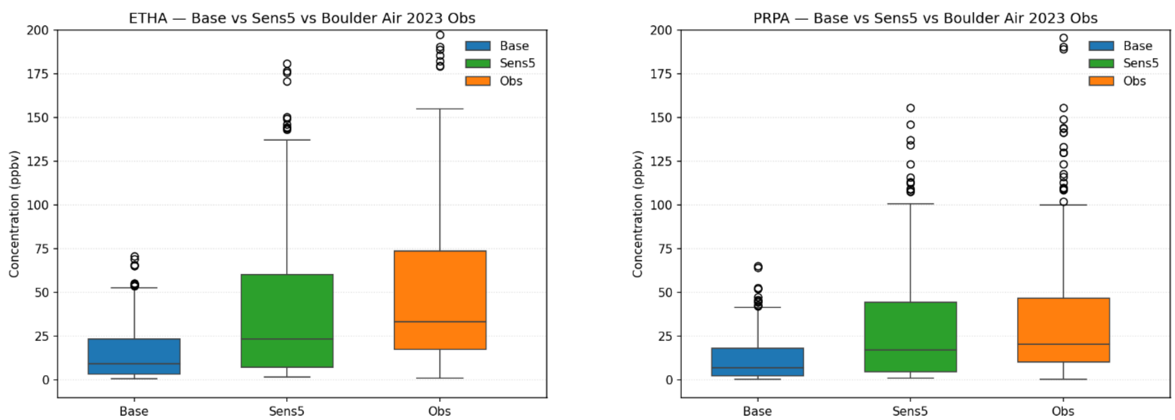

Figure 1-4. Comparison of the frequency distribution of the predicted and observed (orange) hourly Ethane (left) and Propane (right) concentrations at Loving, New Mexico site for the CAMx 2022v2 base case (blue) and the CAMx 3 times New Mexico Permian Basin NO_X and VOC emissions Sens5 sensitivity test (green).

2.0 DEVELOPMENT OF 2032 OIL AND GAS EMISSIONS FOR THE NEW MEXICO 4 KM DOMAIN

A 2032 future year oil and gas emissions inventory, including nonpoint and point sources, was developed for the New Mexico 4 km modeling domain. The 2032 future year oil and gas emissions inventory for nonpoint and point sources was projected from the EPA 2022v2 Emissions Modeling Platform (EMP; EPA, 2025b) 2022 base year emissions accounting for changes from the base year to future year in oil and gas activity and emissions controls for on-the-books regulatory programs. The on-the-book control programs were the same as used by EPA in their 2022v1 EMP 2026 projections published in May 2025 (EPA, 2025a) so do not include some of the latest proposed and final changes in regulatory rules (e.g., April 2026 reconsideration of OOOOb/c[7]).

2.1 Geographic Area and Temporal Scale

An annual 2032 oil and gas emission inventory was developed for the New Mexico 4 km modeling domain shown in Figures 1-2 and 1-3. The main oil and gas producing areas within the domain are the Permian Basin in southeast New Mexico (NM) and western Texas (TX) and the San Juan Basin in northwest NM and southwest Colorado (CO).

2.2 Sources and Pollutants

The 2032 New Mexico 4 km modeling domain emissions inventory includes criteria air pollutants precursors: NO_x (oxides of nitrogen), CO (carbon monoxide), PM_{10} (particulate matter less than ten microns) and $PM_{2.5}$ (particulate matter less than 2.5 microns), SO_2 (sulfur dioxide), and VOC (volatile organic compounds).

The emissions inventory includes well sites, gathering and processing subsectors. Emissions from well-site sources are classified as nonpoint sources and include exploration and production phase sources. Well site emissions include exploration phase emissions from sources such as drill rigs and hydraulic fracturing engines and production phase emissions from sources such as tanks, pneumatic controllers, fugitive leaks, and artificial lift engines. The gathering and processing subsectors are collectively referred to as “midstream” sources; emissions from midstream sources are classified as point sources and include emissions from compressor stations and gas processing plants.

2.3 2032 Emission Inventory Development Approach

The 2032 4 km modeling domain oil and gas emissions inventory was developed for nonpoint and point sources following an approach similar to that used by EPA to develop the 2022v1 EMP future year 2026 emission inventory (EPA, 2025a), accounting for changes to oil and gas activity and emission controls from the 2022v2 base year 2022 emissions inventory to the future year 2032 (EPA, 2025b).

2.3.1 Oil and Gas Activity

The oil and gas activity forecasts and scalars were developed as described below. EPA 2022v1 oil and gas activity surrogate to SCC and North American Industry Classification System (NAICS) code cross-references were used to apply the activity scaling factors to the emission inventory.

[7] https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/2026-final-rule-reduce-burden-oil-and

Oil Production and Gas Production Forecasts

Activity scaling factors were developed to project EPA's 2022v2 base year 2022 oil and gas emissions within the CAMx New Mexico 4 km modeling domain to the future year 2032. As noted above, this 2032 projection follows a similar approach to EPA's 2022v1 emissions inventory projection for the analysis year of 2026 (EPA, 2025a). Historical production data for oil and natural gas production were used to develop growth factors from year 2022 to 2025, and Energy Information Administration (EIA) 2025 Annual Energy Outlook (AEO2025)[8] Reference Case production forecasts were used to develop 2025 to 2032 growth factors. Complete 2025 production data was not readily available for Arizona, Kansas, and Oklahoma and county-level data was not readily available for Arizona and Oklahoma. For Arizona and Kansas, 2024 data were used in place of 2025 data. For Oklahoma, 2025 data were scaled from the available January through November 2025 data. The oil and gas emissions activity scaling factors to forecast emissions from year 2022 to 2032 are estimated as the product of the historical 2022 to 2025 and forecast 2025 to 2032 growth factors.

Table 2-1 presents the 2022 to 2032 activity scaling factors. Growth factors for the combined oil and natural gas activity are the average of the oil and natural gas growth factors. Growth factors were also calculated on a lower 48-state basis for oil pipeline (1.12) and natural gas pipeline (1.19) activities. For the New Mexico portion of the Permian Basin (e.g., Eddy and Lea Counties), there are larger 2022 to 2032 O&G growth factors (e.g., 1.34 oil production growth in Eddy County) than in the Texas portion of the Permian Basin, some of which show decline (e.g., 0.92 growth factor for oil production).

[8] Accessed online in June 2026 at https://www.eia.gov/outlooks/archive/aeo25/

Table 2-1. 4 km Modeling Domain 2022 to 2032 oil and natural gas production activity scaling factors.

State	County/Region	Composite Growth Factor (2022 to 2032)		
		Oil Production	Natural Gas Production	Both Production
New Mexico	Chavez	0.93	0.74	0.83
	Colfax	0.90	0.68	0.79
	Eddy	1.34	1.39	1.37
	Lea	1.13	1.39	1.26
	Roosevelt	0.24	0.71	0.48
	McKinley	2.14	1.18	1.64
	Rio Arriva	1.04	0.68	0.86
	San Juan	1.18	0.97	1.07
	Sandoval	1.10	0.82	0.96
	Southwest Region[1] New Mexicowide	1.22	1.38	N/A
	Rocky Mountain[1] Region New Mexicowide	1.24	1.05	N/A
Texas	Southwest Region[1] Texaswide	0.92	1.08	1.00
	Mid Continent Region[1] Texaswide	0.76	0.79	0.77
Arizona	All counties	3.25	0.77	1.96
Colorado	All counties	0.75	0.81	0.78
Kansas	All counties	1.02	0.86	0.94
Oklahoma	All counties	1.00	1.02	1.01
Utah	All counties	1.15	1.20	1.18

[1] EIA's oil and gas supply regions are available in the EIA (2023) "Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2023" (https://www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063(2023).pdf).

Table 2-2 presents the forecast 2032 oil and natural gas production for the 4 km modeling domain.

Table 2-2. 4 km Modeling Domain forecast 2032 oil and natural gas production

State	County/Region	2032 Annual Production	
		Oil (thousand bbl/yr)	Natural Gas (tcf/yr)
New Mexico	Chavez	1,518	8
	Colfax	-	9
	Eddy	314,321	1,639
	Lea	389,281	1,377
	Roosevelt	403	1
	McKinley	2	0
	Rio Arriva	1,935	242
	San Juan	8,404	282
	Sandoval	2,466	9
	Southwest Region[1] New Mexicowide	705,524	3,034
	Rocky Mountain[1] Region New Mexicowide	12,807	533
Texas	Southwest Region[1] Texaswide	1,092,851	3,856
	Mid Continent Region[1] Texaswide	6,084	40
Arizona	All counties	0	0
Colorado	All counties	80	224
Kansas	All counties	6,153	93
Oklahoma	All counties	151	3
Utah	All counties	2,693	8
Total Permian Basin		**1,796,031**	**6,878**
Total Modeling Domain		**1,826,344**	**7,790**

[1] EIA's oil and gas supply regions are available in the EIA (2023) "Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2023" (https://www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063(2023).pdf).

Exploration Forecasts

Exploration refers to activities such as drilling, hydraulic fracturing, and completion which occur during oil and gas well development. EPA developed exploration growth factors to forecast the 2022v1 base year 2022 emission inventory to 2026 based on the average of exploration data for historical years 2018, 2019, and 2022. Readily available Baker Hughes yearly historical rig counts were used as the basis to forecast future year activity for the Permian Basin[9]. The Permian Basin-level exploration growth factor is estimated to be 0.93 based on the ratio of (i) average annual 2019 to 2025 rig count to (ii) 2022 annual rig count

[9] Baker Hughes North American Rotary Rig Count. Accessed online in June 2026 at https://rigcount.bakerhughes.com/na-rig-count.

(see Table 2-3). Outside of the Permian Basin, no change in exploration activity was assumed from 2022 to 2032.

Table 2-3. 2019 to 2025 Permian Basin Annual Rig Counts

Region	2019	2020	2021	2022	2023	2024	2025
Permian Basin	449.3	221.3	243.2	342.2	340.3	332.1	299.7

2.3.2 Controls

Emissions reductions resulting from regulatory programs such as New Source Performance Standards (NSPS) controls (for example, oil and gas, reciprocating internal combustion engines (RICE), natural gas turbines, and process heaters) and state-specific regulatory programs were incorporated into the 2032 emission estimates. Following the approach in EPA's 2022v1 EMP 2026v1 emissions projections, emission control estimates were based on the suite of regulations that were "on-the-books" at the time the EPA 2026v1 future year emissions inventory was developed (May 2025). Similar to the approach applied in the 2022v1 modeling platform 2026 future year emission inventories, no controls were applied to exploration emissions. The 2032 nonpoint production and point control factors for all the states within the modeling domain were developed as described below.

Texas, Arizona, Colorado, Kansas, Oklahoma, and Utah: Nonpoint production and point source control factors were developed based on the EPA 2022v1 Control Strategies Tool (CoST) methodology and input assumptions (EPA 2025a).

New Mexico: The EPA2022v1 2026 emissions inventory includes control assumptions based on the NMED Ozone Precursor Rulemaking[10]. For this analysis, NMED provided control factors based on the final Ozone Precursor Rulemaking[11] and applicable federal regulations. Table 2-4 and Table 2-5 shows the NO_x and VOC control factors by SCC for nonpoint and point sources, respectively. County-specific control factors were not available; therefore, the same SCC-level control factors were applied to all New Mexico counties.

[10] Accessed online in June 2026 at https://www.env.nm.gov/air-quality/ozone-draft-rule/

[11] Email from NM Environment Department (NMED; Angela Raso), October 11, 2023.

Table 2-4. New Mexico nonpoint NO_x and VOC control factors by SCC.

SCC[1]	SCC Level Four	NO_x Control Factors	VOC Control Factors
2310020600	Compressor Engines	29%	8%
2310021351	Lateral Compressors 4 Cycle Rich Burn	11%	4%
2310023351	Lateral Compressors 4 Cycle Rich Burn	11%	4%
2310010700	Oil Well Fugitives	0%	75%
2310021509	Fugitives: All Processes	0%	75%
2310023509	Fugitives	0%	75%
2310021603	Gas Well Venting - Blowdowns	0%	50%
2310011000	Total: All Processes	0%	21%
2310021400	Gas Well Dehydrators	0%	46%
2310023400	Dehydrators	0%	46%
2310010100	Oil Well Heaters	16%	0%
2310021100	Gas Well Heaters	16%	0%
2310023100	CBM Well Heaters	16%	0%
2310010800	Oil Well Truck Loading	0%	87%
2310020800	Gas Well Truck Loading	0%	87%
2310010300	Oil Well Pneumatic Devices	0%	91%
2310021300	Gas Well Pneumatic Devices	0%	91%
2310021310	Gas Well Pneumatic Pumps	0%	91%
2310023300	Pneumatic Devices	0%	91%
2310111401	Oil Well Pneumatic Pumps	0%	91%
2310000550	Produced Water	0%	53%
2310010200	Oil Well Tanks - Flashing & Standing/Working/Breathing	0%	53%
2310030220	Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled	0%	53%

[1]SCCs for which NO_X and VOC control factors were both 0% and are excluded

Table 2-5. New Mexico point NO_x and VOC control factors by SCC.

SCC[1]	SCC Level Four	NO_x Control Factors	VOC Control Factors
31000309	Compressor Seals	0.0%	51.3%
20100201	Turbine	67.7%	7.8%
20100202	Reciprocating	7.0%	17.0%
20200201	Turbine	29.5%	51.0%
20200202	Reciprocating	7.0%	17.0%
20200252	2-cycle Lean Burn	47.3%	4.9%
20200253	4-cycle Rich Burn	10.9%	3.6%
20200254	4-cycle Lean Burn	40.0%	7.8%
20200255	2-cycle Clean Burn	69.6%	0.0%
20200256	4-cycle Clean Burn	39.9%	7.4%
31000203	Compressors (See also 310003-12 and -13)	24.1%	8.4%

SCC[1]	SCC Level Four	NO_x Control Factors	VOC Control Factors
20280001	Equipment Leaks	0.0%	75.1%
30688801	Specify in Comments Field	0.0%	75.1%
30699999	Not Classified **	0.0%	75.1%
31000101	Well Completion	0.0%	75.1%
31000199	Processing Operations: Not Classified	0.0%	75.1%
31000204	Wells	0.0%	75.1%
31000207	Valves: Fugitive Emissions	0.0%	75.1%
31000220	All Equipt Leak Fugitives (Valves, Flanges, Connections, Seals, Drains	0.0%	75.1%
31000223	Relief Valves	0.0%	75.1%
31000226	Flanges and Connections	0.0%	75.1%
31000229	Gathering Lines	0.0%	75.1%
31000231	Fugitives: Drains	0.0%	75.1%
31000299	Other Not Classified	0.0%	75.1%
31000306	Process Valves	0.0%	75.1%
31088801	Specify in Comments Field	0.0%	75.1%
31088811	Fugitive Emissions	0.0%	75.1%
40688801	General	0.0%	75.1%
31000227	Glycol Dehydrator Reboiler Still Stack	0.0%	46.2%
31000301	Glycol Dehydrator Reboiler Still Stack	0.0%	46.2%
31000304	Glycol Dehydrator (See also 31000301-31000303)	0.0%	46.2%
10100501	Boiler	16.0%	0.0%
10100602	Boiler < 100 Million BTU, except tangential	16.0%	0.0%
10200601	> 100 Million BTU/hr	16.0%	0.0%
10200602	10-100 Million BTU/hr	16.0%	0.0%
30600104	Gas-fired	16.0%	0.0%
30600105	Natural Gas-fired	16.0%	0.0%
31000228	Glycol Dehydrator Reboiler Burner	16.0%	0.0%
31000302	Glycol Dehydrator Burner Stack	16.0%	0.0%
31000403	Crude Oil	16.0%	0.0%
31000404	Natural Gas	16.0%	0.0%
31000405	Process Gas	16.0%	0.0%
2310011100	Heater Treater	16.0%	0.0%
40400150	Miscellaneous Losses/Leaks: Loading Racks	0.0%	86.8%
40400154	Tank Truck Vapor Leaks	0.0%	86.8%
40400250	Loading Racks	0.0%	86.8%
40600132	Crude Oil: Submerged Loading (Normal Service)	0.0%	86.8%
40600148	Crude Oil: Submerged Loading (Clean Tanks)	0.0%	86.8%
40600164	Crude Oil: Loaded with Product (Transit Losses)	0.0%	86.8%
40600198	Not Classified **	0.0%	86.8%

SCC[1]	SCC Level Four	NO_x Control Factors	VOC Control Factors
40600199	Other Not Classified	0.0%	86.8%
40899995	Cars/Trucks: Loading Rack	0.0%	86.8%
2505030030	Crude Oil	0.0%	86.8%
40400199	Other Not Classified	0.0%	53.1%
31000126	Pump Seals	0.0%	90.6%
31000325	Pneumatic Controllers, High Bleed >6 scfh	0.0%	90.6%
31000107	Oil/Gas/Water/Separation	0.0%	53.1%
31000132	Atmospheric Wash Tank (2nd Stage of Gas-Oil Separation): Flashing Loss	0.0%	53.1%
31000506	Oil-Water Separation Wastewater Holding Tanks	0.0%	53.1%
40301011	Crude Oil RVP 5: Breathing Loss (250000 Bbl. Tank Size)	0.0%	53.1%
40301012	Crude Oil RVP 5: Working Loss (Tank Diameter Independent)	0.0%	53.1%
40301099	Other Liquids: Working Loss (Tank Diameter Independent)	0.0%	53.1%
40301142	Crude Oil: Breathing Loss - External - Secondary Seal	0.0%	53.1%
40301152	Crude Oil: Breathing Loss - Internal	0.0%	53.1%
40400179	Other Liquids: Working Loss - Int. Float Roof (Pri/Sec Seal)	0.0%	53.1%
40400301	Fixed Roof Tank: Breathing Loss	0.0%	53.1%
40400302	Fixed Roof Tank: Working Loss	0.0%	53.1%
40400303	External Floating Roof Tank with Primary Seals: Breathing Loss	0.0%	53.1%
40400304	External Floating Roof Tank with Secondary Seals: Breathing Loss	0.0%	53.1%
40400311	Fixed Roof Tank, Condensate, working+breathing+flashing losses	0.0%	53.1%
40400312	Fixed Roof Tank, Crude Oil, working+breathing+flashing losses	0.0%	53.1%
40400313	Fixed Roof Tank, Lube Oil, working+breathing+flashing losses	0.0%	53.1%
40400314	Fixed Roof Tank, Specialty Chem- working+breathing+flashing	0.0%	53.1%
40400315	Fixed Roof Tank, Produced Water, working+breathing+flashing	0.0%	53.1%
40400321	External Floating Roof Tank, Condensate, working+breathing+flashing	0.0%	53.1%
40400322	External Floating Roof Tank, Crude Oil, working+breathing+flashing	0.0%	53.1%
40400332	Internal Floating Roof Tank, Crude Oil, working+breathing+flashing	0.0%	53.1%
2501050030	Crude Oil	0.0%	53.1%

[1]SCCs for which NO_X and VOC control factors were both 0% are excluded

2.4 Results

Table 2-6 shows 2032 4 km modeling domain nonpoint and point source emissions inventory estimates by state and Table 2-7 shows these emissions for the Permian Basin. For Permian Basin-wide and for the New Mexico portion of the Permian Basin, nonpoint sources were the largest source of emissions for most pollutants except for PM_{10} for which point sources are the largest source of emissions. In Texas, nonpoint sources were the largest source of emissions for most pollutants except for PM_{10} and $PM_{2.5}$ for which point sources are the largest source of emissions. In Arizona, nonpoint sources were the largest source of emissions for most pollutants except for PM_{10}, $PM_{2.5}$, and SO_2 for which point sources are the largest source of emissions. In Colorado, nonpoint sources were the largest source of emissions for all pollutants. In Kansas, nonpoint sources were the largest source of emissions for most pollutants except for NOx and SO_2 for which point sources are the largest source of emissions. In Oklahoma and Utah, nonpoint sources were the largest source of emissions for most pollutants except for NOx, PM_{10}, and $PM_{2.5}$ for which point sources are the largest source of emissions.

The contributions of source types to New Mexico Permian Basin O&G emissions are shown in Figure 2-1 for NO_X and Figure 2-2 for VOC. The three largest sources of NO_X comprise approximately three quarters of Permian Basin, New Mexico NOx emissions are artificial lift engines (35%), point engines and turbines (26%), and drill rigs (14%). Nonpoint tanks comprise a majority (54%) of the VOC emissions, with lesser contributions from several source categories such as artificial lift engines, point flaring, and associated gas venting.

Table 2-6. Summary 2032 CAMx 4 km Modeling Domain oil and gas emissions by state (short tons/year)

State	Pollutants	Nonpoint	Point	Total
New Mexico	Carbon Monoxide	102,199	44,560	146,759
	Nitrogen Oxides	66,083	38,483	104,566
	PM_{10} - Total	2,078	2,082	4,160
	$PM_{2.5}$ - Total	2,070	1,755	3,825
	Sulfur Dioxide	113,705	7,711	121,415
	Volatile Organic Chemicals	208,610	47,169	255,779
Texas	Carbon Monoxide	100,348	14,775	115,123
	Nitrogen Oxides	78,392	27,674	106,066
	PM_{10} - Total	975	1,325	2,300
	$PM_{2.5}$ - Total	972	1,307	2,279
	Sulfur Dioxide	113,298	5,536	118,834
	Volatile Organic Chemicals	422,865	8,175	431,040
Arizona[1]	Carbon Monoxide	19	37	56
	Nitrogen Oxides	13	395	408
	PM_{10} - Total	0	7	7
	$PM_{2.5}$ - Total	0	7	7
	Sulfur Dioxide	2	4	5
	Volatile Organic Chemicals	97	3	100
Colorado[1]	Carbon Monoxide	12,962	530	13,492
	Nitrogen Oxides	11,471	948	12,419
	PM_{10} - Total	202	10	212
	$PM_{2.5}$ - Total	201	10	210
	Sulfur Dioxide	10	2	12
	Volatile Organic Chemicals	694	311	1,005

State	Pollutants	Nonpoint	Point	Total
Kansas[1]	Carbon Monoxide	8,216	3,956	12,172
	Nitrogen Oxides	5,520	9,297	14,816
	PM_{10} - Total	203	152	354
	$PM_{2.5}$ - Total	203	152	354
	Sulfur Dioxide	5	12	17
	Volatile Organic Chemicals	6,405	1,255	7,659
Oklahoma[1]	Carbon Monoxide	9,843	5,953	15,796
	Nitrogen Oxides	8,665	9,809	18,474
	PM_{10} - Total	251	279	530
	$PM_{2.5}$ - Total	246	276	522
	Sulfur Dioxide	6	88	94
	Volatile Organic Chemicals	15,527	5,177	20,704
Utah[1]	Carbon Monoxide	247	283	530
	Nitrogen Oxides	154	269	423
	PM_{10} - Total	2	43	45
	$PM_{2.5}$ - Total	2	42	44
	Sulfur Dioxide	41	1	42
	Volatile Organic Chemicals	466	32	497

[1] Includes emissions only from the portion of the state in the 4 km modeling domain

Table 2-7. Summary 2032 Permian Basin oil and gas emissions (short tons/year)

State/Region	Pollutants	Nonpoint	Point	Total
Total Permian Basin	Carbon Monoxide	162,021	44,988	207,009
	Nitrogen Oxides	116,945	47,525	164,470
	PM_{10} - Total	2,625	2,952	5,577
	$PM_{2.5}$ - Total	2,615	2,615	5,230
	Sulfur Dioxide	226,764	13,003	239,767
	Volatile Organic Chemicals	577,549	45,940	623,489
New Mexico Permian Basin counties	Carbon Monoxide	66,645	31,995	98,640
	Nitrogen Oxides	42,709	25,598	68,307
	PM_{10} - Total	1,799	1,749	3,547
	$PM_{2.5}$ - Total	1,791	1,430	3,221
	Sulfur Dioxide	113,698	7,624	121,322
	Volatile Organic Chemicals	170,284	38,691	208,975
Texas Permian Basin counties	Carbon Monoxide	95,376	12,993	108,369
	Nitrogen Oxides	74,236	21,927	96,163
	PM_{10} - Total	826	1,203	2,030
	$PM_{2.5}$ - Total	824	1,185	2,009
	Sulfur Dioxide	113,066	5,379	118,445
	Volatile Organic Chemicals	407,265	7,249	414,514

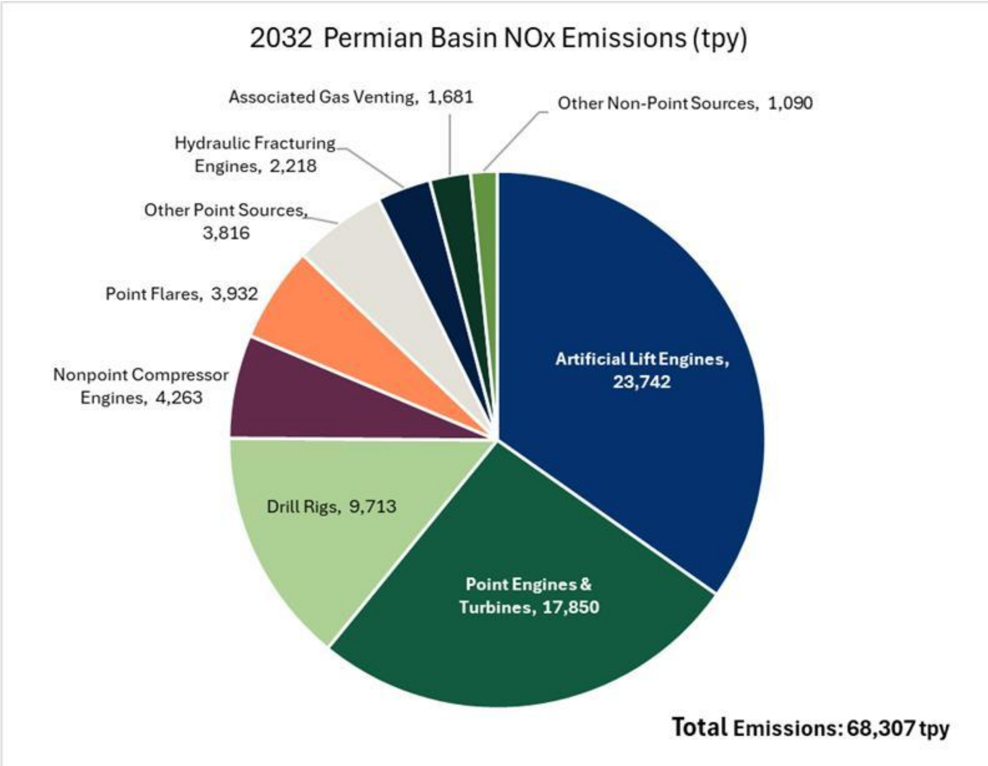

Figure 2-1. 2032 Permian Basin, New Mexico oil and gas NOx emissions by source.

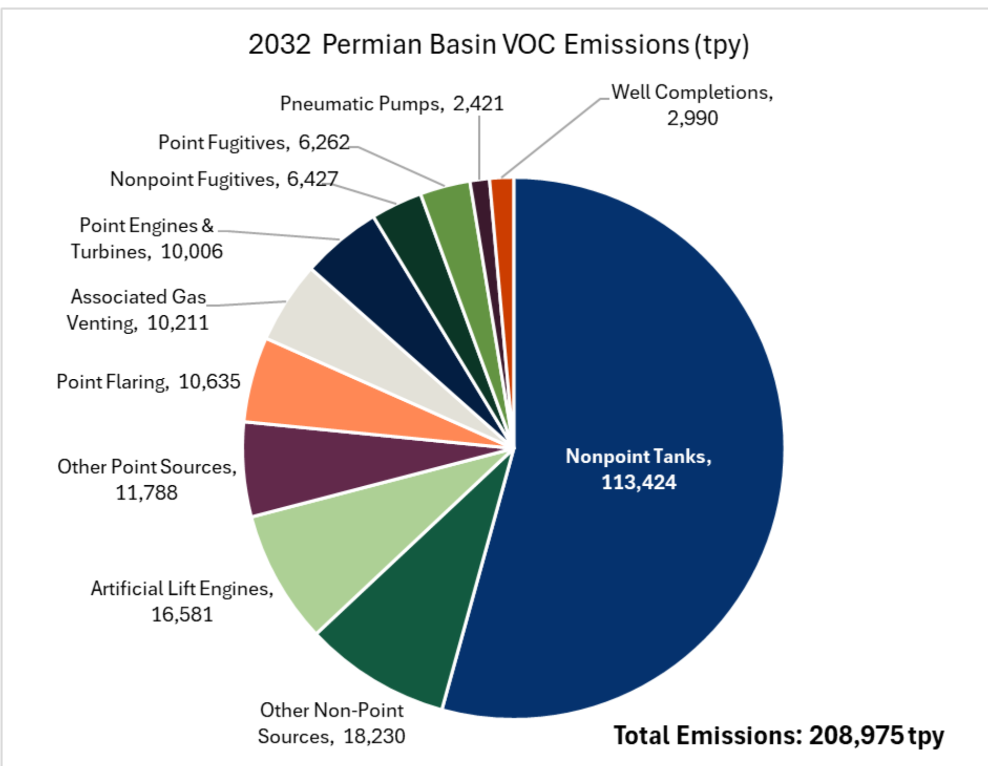

Figure 2-2. 2032 Permian Basin, New Mexico oil and gas VOC emissions by source.

3.0 DEVELOPMENT OF 2032 EMISSION INPUTS FOR THE CAMX 2022V2 12/4 KM MODELING PLATFORM

This chapter describes the development of the 2032 emissions used in the CAMx 2022v2 modeling platform. These inventories were based on EPA's 2022v2[12] and 2022v1[13] Emissions Modeling Platforms (EMPs)[14] developed by the National Emissions Collaborative (NEC). Both platforms are based on the 2020 National Emissions Inventory (NEI) with updates to better represent the year 2022 (EPA, 2023; EPA 2025a and 2025b). The platforms contain emissions inventories for 2022, spatial surrogates, temporal profiles, and other ancillary files needed for air quality modeling. One key difference between the two platforms is that the 2022v1 EMP includes projected emissions inventories and model-ready emissions for the 2026 analytical year, whereas the 2022v2 EMP doesn't include future year analytical inventories.

EPA processed both the 2022v1 emissions platform, including the 2026 projection inventory, and the 2022v2 emissions platform to generate model-ready emissions for the 12 km Continental U.S. (CONUS) domain. These 12 km model-ready emissions were downloaded from EPA and used in the NMED Phase II CAMx 2022v2 12/4 km modeling platform. For the higher-resolution 4 km domain, EPA emissions inventories were downloaded by source sector and processed using the Sparse Matrix Operator Kernel Emissions v5.0 (SMOKE) modeling system to generate model-ready 2022 emissions for the New Mexico 4 km domain (Ramboll, 2026b). Below we describe how the CAMx 2032 12 km CONUS and 4 km New Mexico domain emissions were developed.

3.1 2032 CONUS 12 km Domain Anthropogenic Emissions

The 2032 future year anthropogenic emissions for the 12 km CONUS domain were developed by source sector using EPA's 2022v1 and 2022v2 platforms as the starting point, with sector-specific scaling or direct substitution methods applied to obtain emissions representative of 2032.

- **Electric Generating Units (EGUs).** The 2032 EGU emissions for the 12 km CONUS domain were represented using the 2026 projections model-ready hourly CONUS EGU emissions from EPA's 2022v1 platform.
- **On-Road Mobile Sources.** The 2032 on-road mobile emissions for the 12 km CONUS domain were developed by applying pollutant-specific 2022-to-2032 scaling factors to the 2022v2 gridded hourly on-road emissions. Scaling factors were derived from MOVES5 Inventory Mode runs using national-level default inputs for both the 2022 base year and 2032 future year, with the ratio of 2032-to-2022 MOVES5 outputs applied uniformly across the domain.
- **Non-Road Mobile Sources.** The 2032 non-road mobile emissions for the 12 km CONUS domain were developed using a scaling approach consistent with the on-road methodology. MOVES5, which incorporates the NONROAD model, was run for 2022 and 2032 to develop scaling factors, which were then applied to the 2022v2 gridded hourly non-road emissions for the 12 km CONUS domain.

[12] https://www.epa.gov/air-emissions-modeling/2022v2-emissions-modeling-platform
[13] https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform
[14] https://www.epa.gov/air-emissions-modeling/2022v2-emissions-modeling-platform

- **Oil and Gas (O&G).** The 2032 O&G emissions for the 12 km CONUS domain were represented using the 2026 future year model-ready O&G emissions from EPA's 2022v1 platform.
- **Non-Point Sources.** Nonpoint source emissions, including solvents, residential wood combustion, and agricultural sources, for the 12 km CONUS domain were held constant at the 2026 level using the 2026 gridded hourly emissions from EPA's 2022v1 platform.
- **Non-EGU Point Sources.** Non-EGU point source emissions for the 12 km CONUS domain were also held constant at the 2026 emissions level using the 2026 model-ready emissions from EPA's 2022v1 platform.
- **Airports and Rail.** Airport and rail emissions for the 12 km CONUS domain were held constant at the 2026 level using the 2026 gridded hourly emissions from EPA's 2022v1 platform.
- **Commercial Marine Vessels (CMV).** CMV emissions for the 12 km CONUS domain were held constant at the 2026 level using the 2026 gridded hourly emissions from EPA's 2022v1 platform.

The CMAQ-format point and gridded emissions files were downloaded from EPA's Open Data Program and converted to CAMx NetCDF format using the CMAQ2CAMx processor. To avoid double counting, point-source oil and gas emissions within the nested 4 km NMED domain were removed from the 12 km emissions inventory and replaced with the higher-resolution 4 km emissions described in Chapter 2. Table 3-1 summarizes the emissions data sources used for the 12 km CAMx modeling.

3.2 2032 New Mexico 4 km Domain Anthropogenic Emissions

The 2032 future year anthropogenic emissions for the 4 km domain were developed by source sector using EPA's 2022v1 and 2022v2 EMPs as the foundation. Emissions were projected to 2032 on a sector-by-sector basis using a combination of scaling approaches, SMOKE processing, and direct substitution of available future year emissions, depending on the source category.

- **Oil and Gas (O&G).** The 2032 O&G emissions for the New Mexico 4 km domain are based on the inventory development described in Chapter 2. These emissions were processed through SMOKE using ancillary data from EPA’s 2022v2 EMP, including chemical speciation, spatial allocation, and temporal profiles.
- **Electric Generating Units (EGU).** Consistent with the 12 km CONUS domain, 2032 EGU emissions for the 4 km domain were represented using the 2026 model-ready EGU emissions from EPA’s 2022v1 platform.
- **On-Road Mobile Sources.** The 2032 on-road mobile emissions were developed by applying county- and pollutant-specific 2022-to-2032 scaling factors to the 2022v2 gridded hourly on-road emissions. These scaling factors were derived from MOVES5 Inventory Mode runs conducted for representative counties using inputs from EPA’s 2022v2 platform. A representative-to-actual county crosswalk, along with grid cell masking, was then used to distribute the county-level scaling factors across the 4 km modeling domain.
- **Non-Road Mobile Sources.** Non-Road mobile emissions were developed using a scaling approach consistent with the on-road methodology. MOVES5, which

incorporates the NONROAD model, was run for both 2022 and 2032 to develop scaling factors. These factors were then applied to the 2022v2 gridded hourly non-road emissions for the 4 km domain.

- **Non-Point Sources.** Nonpoint emissions, including fugitive dust, solvents, and other nonpoint categories, were held constant at 2026 levels, except for selected sectors such as residential wood combustion (RWC) and agricultural sources, which were held constant at 2022 levels based on EPA's 2022v2 inventory. These inventories were processed through SMOKE for the 4 km domain.
- **Non-EGU Point Sources.** Non-EGU point source emissions were held constant at the 2026 levels using the 2026 gridded hourly emissions from EPA's 2022v1 platform.
- **Airports and Rail.** Airport and rail emissions were also held constant at 2026 levels. The 2026v1 emissions were processed through SMOKE for the 4 km domain.

Table 3-1 summarizes the inventory data sources used for the 4 km domain. SMOKE was used to process emissions for this domain using spatial surrogates, temporal profiles, and other ancillary inputs from the 2022v2 EMP.

Point source emissions (EGU, Non-EGU, fires) are not grid-specific and were taken directly from the EPA platforms as described above. To avoid double counting, oil and gas point source emissions within the nested 4 km NMED domain were removed from the 12 km model-ready EPA emissions and replaced with the emissions developed in this project (Chapter 2). Nonpoint O&G emissions were developed in this project (Chapter 2) were separated into preproduction and production sectors and processed through SMOKE to support source apportionment. Unlike most emission inputs, agricultural fertilizer emissions were not processed through SMOKE. Instead, they were generated inline during EPA's CMAQ bidirectional model simulations and then spatially disaggregated from the 12 km grid to the NMED 4 km domain.

Table 3-1. Emissions data sources for the New Mexico 4 km and CONUS 12 km domains used in the CAMx 2032 NMED Phase II simulations.

Source Category	NMED 4km Domain (4km grid)	12US2 CONUS (12km grid)
Area: *afdust, nonpt, solvents*	EPA 2022v1 2026 inventory	EPA 2022v1 2026 model-ready emissions
livestock	EPA 2022v2 inventory	EPA 2022v1 2026 model-ready emissions
rwc, openburn	EPA 2022v2 inventory	EPA 2022v1 2026 model-ready emissions
Agricultural fertilizer: *Fertilizer*	EPA 2022v1 emissions spatially subset from 12US2 to the NMED 4 km domain	EPA 2022v1 model-ready emissions
Oil & Gas: *pt_oilgas*	Ramboll developed 2032 inventory processed through SMOKE	EPA 2022v1 2026 model-ready emissions (excluding nested 4 km domain)
np_oilgas	Ramboll developed 2032 inventory processed through SMOKE and separated into preproduction and production sectors	EPA 2022v1 2026 model-ready emissions
On-Road Mobile: *on-road*	SMOKE-MOVES/MOVES5 with 4 km NMED met data; EPA 2022v2 (2022) scaled to 2032 using county-level MOVES5 scaling factors	SMOKE-MOVES/MOVES5 with 4 km NMED met data; EPA 2022v2 (2022) scaled to 2032 using national-level MOVES5 scaling factors
Non-Road: *non-road*	EPA 2022v2 (2022) scaled to 2032 using county-level MOVES5 factors	EPA 2022v2 model-ready (2022) emissions scaled to 2032 using national MOVES5 factors
Airports: *airports*	EPA 2022v1 2026 inventory	EPA 2022v1 2026 model-ready emissions
CMV: *cmv_c1c2, cmv_c3*	N/A	EPA 2022v1 2026 model-ready emissions
Locomotives: *rail*	EPA 2022v1 inventory for 2026	EPA 2022v1 2026 model-ready emissions
EGU Point: *ptegu*	EPA 2022v1 2026 model-ready emissions	EPA 2022v1 2026 model-ready emissions
Point: *ptnonipm*	EPA 2022v1 2026 model-ready emissions	EPA 2022v1 2026 model-ready emissions
Non-US: *Canada/Mexico*	EPA 2022v1 2026 inventory	EPA 2022v1 2026 model-ready emissions
Fires	EPA 2022v2 CAMx-ready emissions	EPA 2022v2 CAMx-ready emissions
Biogenic	2022 BEIS4/BELD6	EPA 2022v2 CAMx-ready emissions
LNOx	EPA 2022v2 data and processor to create 4km emissions data	EPA 2022v2 CAMx-ready emissions

3.3 2032 Natural Source Emission Inputs

All natural source emissions, including biogenic, fires, lightning NOx, and oceanic emissions, were held constant at 2022 levels for the 2032 simulations (Ramboll, 2026b).

3.4 Summary of 2032 Emissions by Source Sector

Table 3-2 and Figure 3-1 show episode-average 2032 anthropogenic NO_X and VOC emissions by source sector in New Mexico, expressed in tons per day (TPD). In 2032, O&G was the largest anthropogenic NOx source, contributing 72% of total emissions, followed by rail at 11%, while all other sectors each contributed 6% or less. For anthropogenic VOC emissions, the O&G sector also dominated, accounting for 82% of the total emissions. It was followed by nonpoint sources at 13% with all remaining sectors contributing 2% or less individually.

Biogenic VOC emissions are not included in these tables and figures. The episode average biogenic VOC emissions (~1,568 TPD) were almost 80% higher than total 2032 anthropogenic VOC emissions in New Mexico. Because biogenic VOC emissions are temperature-sensitive, emissions tend to be higher on days with elevated ozone levels.

Table 3-2. New Mexico 2032 anthropogenic NO_X and VOC emissions by source sector.

	New Mexico	
Tons per Day (TPD)	**2032**	**2032**
Source Sector	**NOx**	**VOC**
EGU Point	14.5	0.7
Non-EGU Point	6.7	5.5
O&G	287.1	713.4
Rail	43.7	1.8
Non-Point	10.9	113.3
Non-Road	8.1	13.3
On-Road	25.7	19.7
Airports	1.8	1.1
Anthro Total	***398.5***	***868.7***

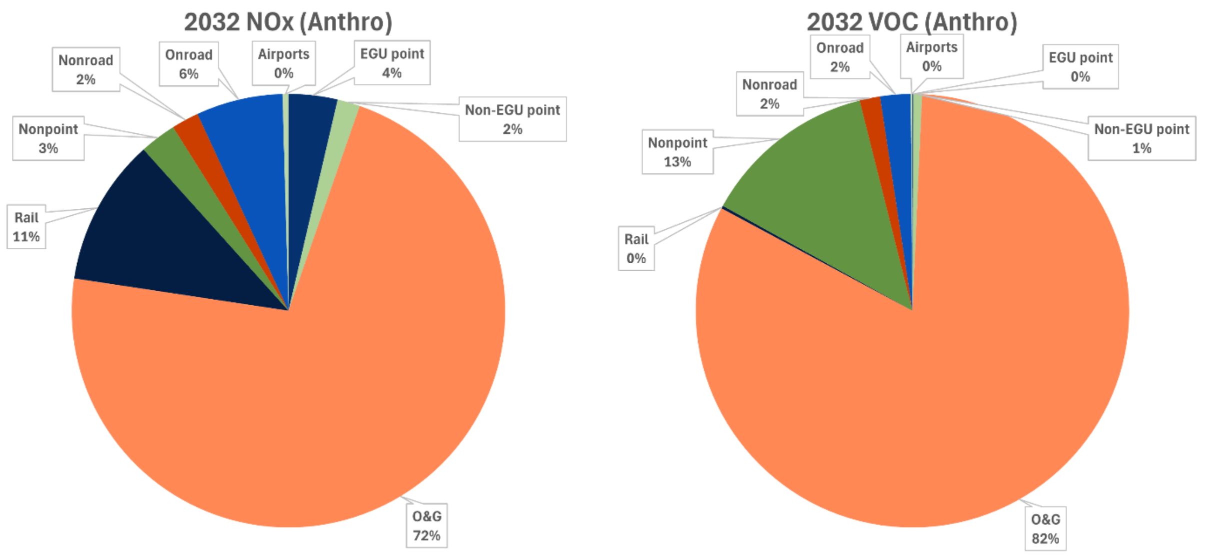

Figure 3-1. Pie Charts showing the percent contributions of 2032 anthropogenic emission source sectors to total anthropogenic NO_X and VOC emissions in New Mexico.

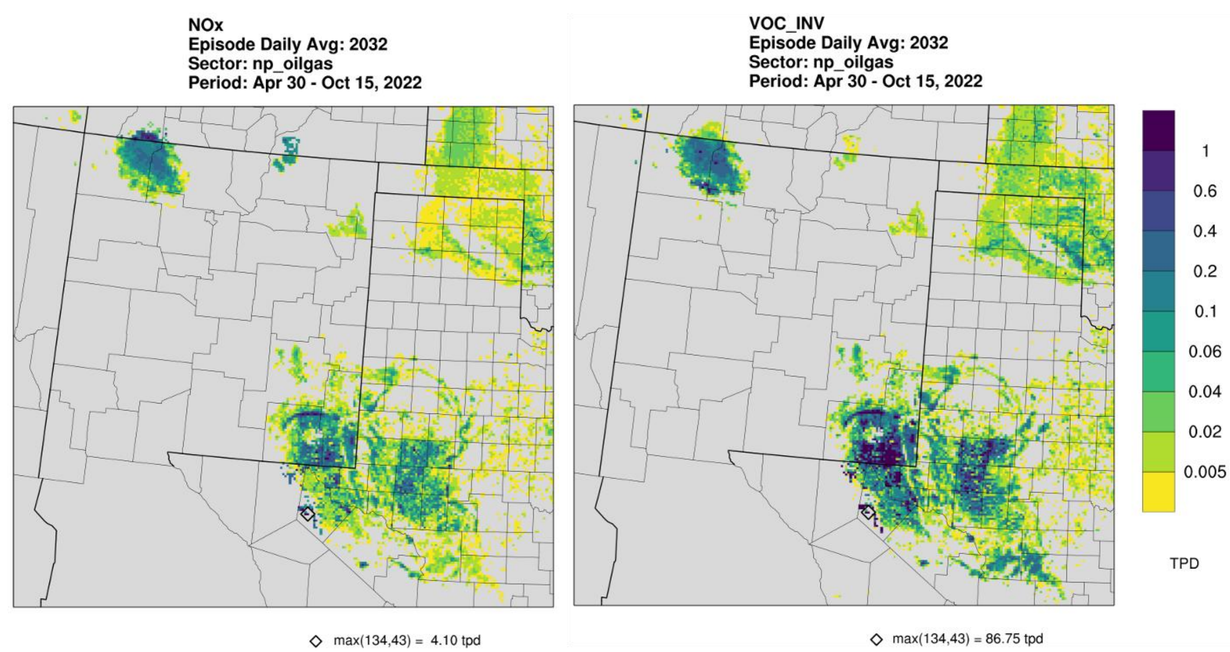

Figure 3-2. Episode-average total 2032 Non-Point O&G NOX (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

Figure 3-2 through Figure 3-6 show the spatial distribution of episode-average 2032 NO_X and VOC emissions within the 4 km domain for the following anthropogenic sectors: non-point O&G, point O&G, on-road mobile, non-road mobile, and non-point. Urban areas, major roadways, and regions of O&G activity are clearly identifiable in the emission maps.

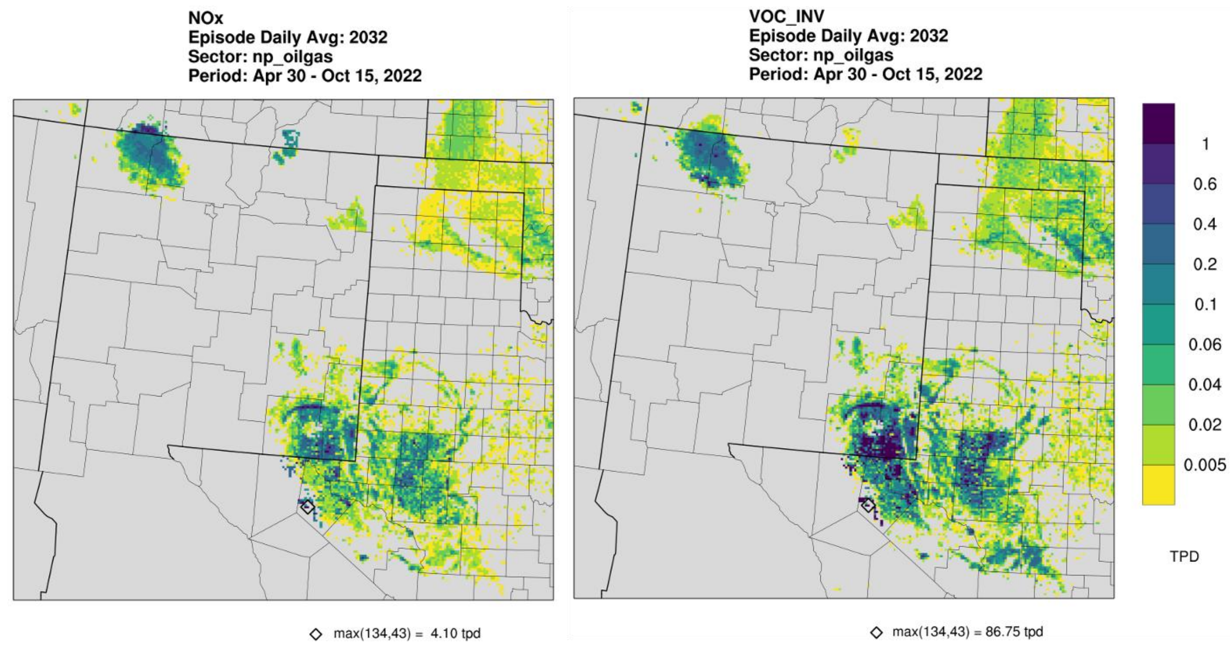

Figure 3-2. Episode-average total 2032 Non-Point O&G NO_X (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

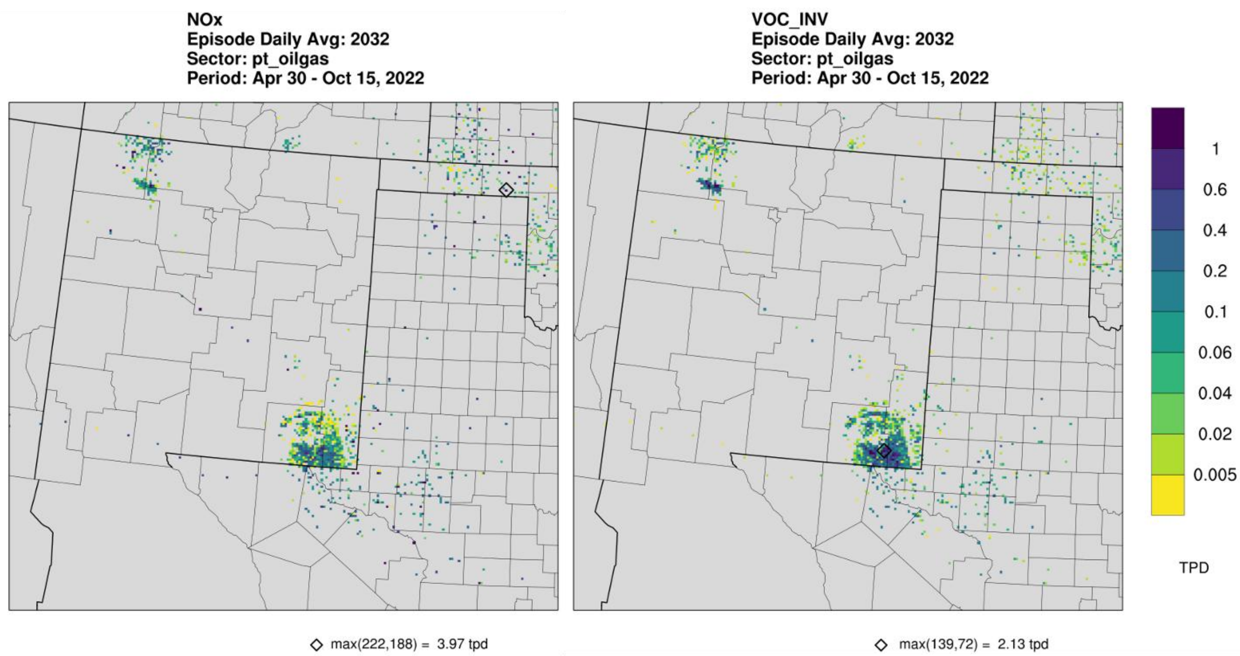

Figure 3-3. Episode-average total 2032 Point O&G NO_X (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

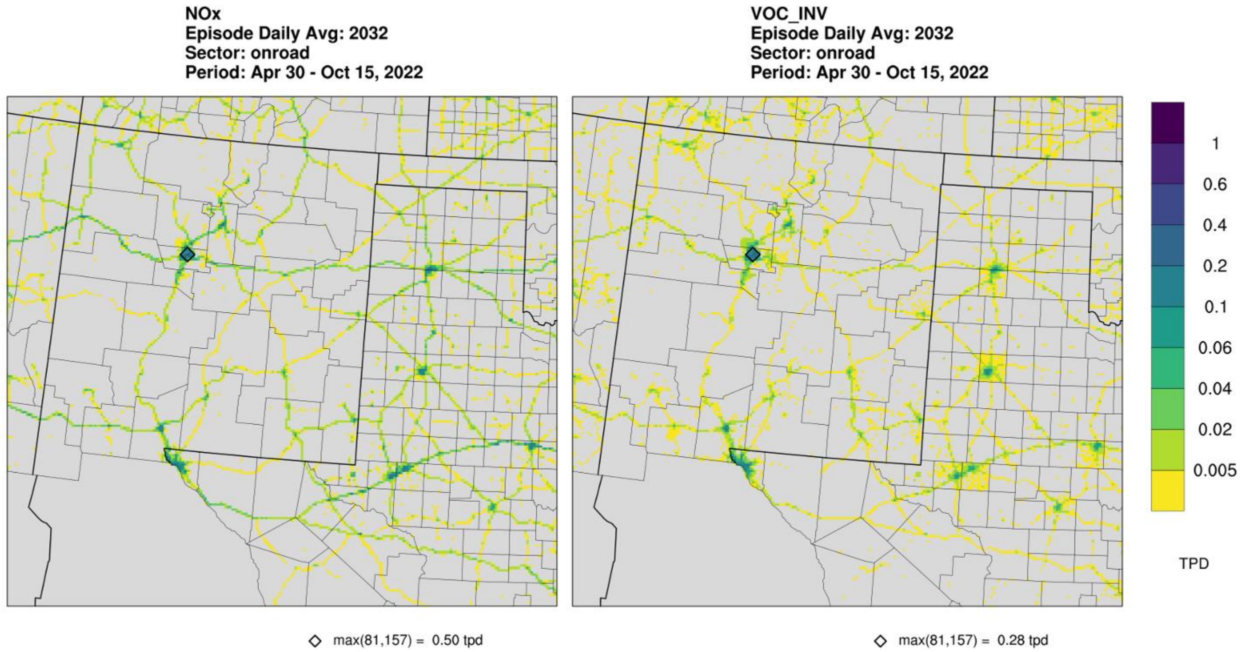

Figure 3-4. Episode-average total 2032 On-Road Mobile NO_X (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

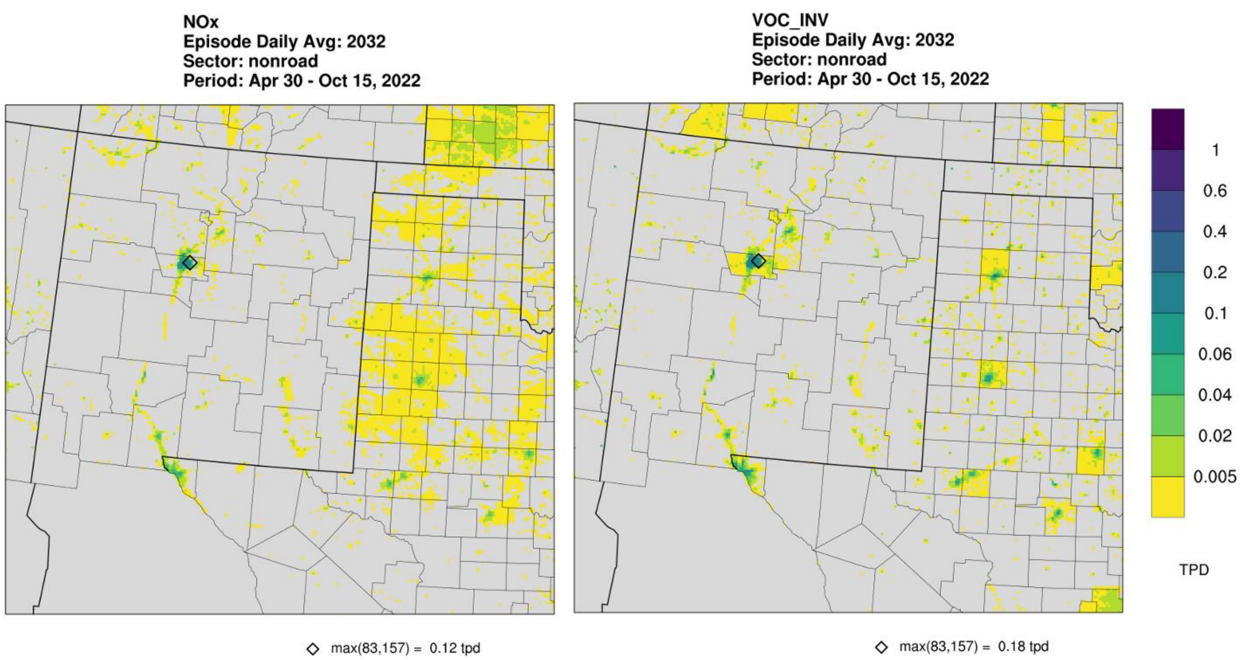

Figure 3-5. Episode-average total 2032 Non-Road Mobile NO_X (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

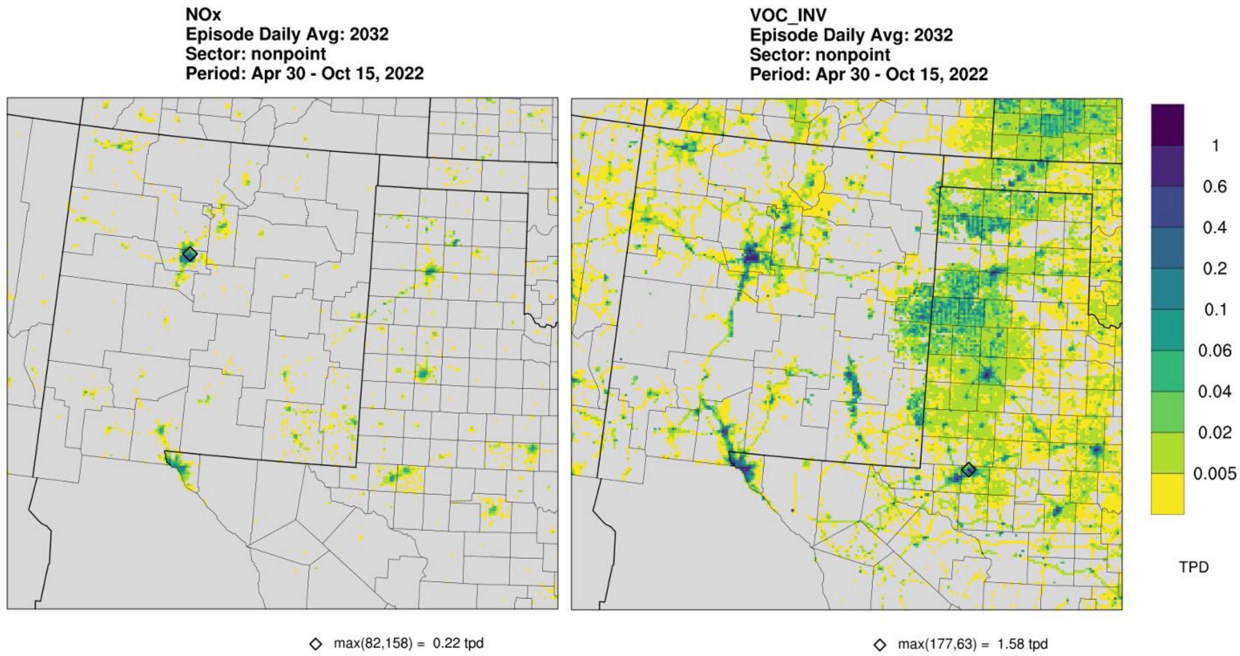

Figure 3-6. Episode-average total 2032 Non-Point NO_X (left) and VOC (right) emissions in the NMED 4 km domain [tons per day (TPD)].

3.5 Comparison of NMED Phase II 2022v2 and 2032 Emissions

This section compares emissions between the 2022v2 base year and 2032 future year inventories used in Phase II of the NMED ozone source apportionment modeling study.

Table 3-3 presents a side-by-side comparison of the New Mexico May-October episode-average emissions (TPD) for 2022v2, based on the EPA 2022v2 platform, and 2032, developed as described in this report.

Anthropogenic NO_X and VOC emissions in New Mexico decreased by approximately -9% and -23%, respectively, in 2032 compared with 2022. The largest reductions occurred in the on-road mobile sector where NO_X and VOC emissions decreased by -67% and -44%, respectively. These reductions are primarily driven by projected fleet turnover. Non-Road mobile emissions also decreased by -32% for NOx and -5% for VOC.

O&G emissions show different trends for NO_X and VOC. New Mexico O&G NO_X emissions increased by +8% in 2032 relative to 2022, while VOC emissions decreased by -26%. The VOC decrease reflects projected controls and other changes included in the future year inventory projections. EGU point source NO_X emissions decreased by -24%, while other sectors (e.g., non-EGU Point) generally showed relatively small changes between 2022 and 2032.

2032 natural emissions, including fires and biogenic sources, were the same as in the 2022 emissions. Biogenic VOC emissions remained substantially larger than anthropogenic VOC emissions, at ~80% higher than 2032 total anthropogenic VOC emissions.

Table 3-3. Emissions by major source sector in New Mexico from 2022v2 and 2032.

	New Mexico					
Tons per Day (TPD)	**2022v2**	**2022v2**	**2032**	**2032**	**%Diff**	**%Diff**
Source Sector	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**
EGU point	19.1	0.6	14.5	0.7	-23.9%	17.0%
Non-EGU point	7.1	5.5	6.7	5.5	-5.1%	-0.2%
O&G	265.9	963.7	287.1	713.4	8.0%	-26.0%
Rail	44.2	1.8	43.7	1.8	-1.2%	-1.7%
Non-Point	11.5	110.2	10.9	113.3	-5.6%	2.8%
Non-Road Mobile	11.9	13.9	8.1	13.3	-31.9%	-4.6%
On-Road Mobile	78.7	35.4	25.7	19.7	-67.3%	-44.3%
Airports	1.7	1.0	1.8	1.1	3.3%	5.7%
Anthro Total	***440.1***	***1132.0***	***398.5***	***868.7***	***-9.4%***	***-23.3%***
Fires	64.3	1872.6	64.3	1872.6	0.0%	0.0%
Biogenic	58.8	1567.6	58.8	1567.6	0.0%	0.0%
Natural Total	***123.1***	***3440.2***	***123.1***	***3440.2***	***0.0%***	***0.0%***

Table 3-4 displays the changes in NO_X and VOC emissions between 2022 and 2032 in the Permian basin potion of Texas. Total NO_X and VOC emissions in the Texas Permian Basin region are estimated to go down between 2022 and 2032 by, respectively, -17% and -50%. Like New Mexico, these NO_X and VOC reductions are driven by reductions in on-road (-63% and -38%) and non-road (-32% and -7%) emissions. However, unlike New Mexico whose Permian Basin NO_X emissions increased by +8%, Texas Permian Basin O&G NO_X emissions are being reduced between 2022 and 2032 by -11. The reduction in New Mexico O&G VOC emissions (-26%) is not as great as seen in the Texas potion of the Permian Basin (-53%).

Table 3-4. Emissions by major source category between 2022 and 2032 in the Texas portion of the Permian Basin.

Texas Permian Basin						
Tons per Day	**2022v2**	**2022v2**	**2032**	**2032**	**Difference (%)**	
Source Sector	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**	**VOC**
EGU point	20.2	0.8	22.5	2.1	11.7%	166.2%
Non-EGU point	6.9	4.9	6.7	5.0	-3.1%	0.6%
O&G	302.9	2339.3	271.2	1109.3	-10.5%	-52.6%
Rail	13.3	0.6	13.2	0.5	-0.8%	-0.7%
Nonpoint	4.9	88.1	4.7	91.0	-4.8%	3.3%
Non-Road	13.9	9.3	9.4	8.7	-32.3%	-6.6%
On-Road	59.4	16.4	23.0	10.2	-61.3%	-37.8%
Airports	1.5	0.9	1.5	0.9	2.3%	2.7%
Anthro Total	***423.0***	***2460.3***	***352.3***	***1227.7***	***-16.7%***	***-50.1%***
Fires	3.6	28.8	3.6	28.8	0.0%	0.0%
Biogenic	112.6	1019.3	112.6	1019.3	0.0%	0.0%
Natural Total	***116.2***	***1048.1***	***116.2***	***1048.1***	***0.0%***	***0.0%***

3.6 2032 Emissions QA/QC

An important step in developing the 2032 emission inputs for the CAMx 2022v2 12/4 km emission scenario was the implementation of Quality Assurance/Quality Control (QA/QC) procedures to ensure the integrity of the emissions data throughout development and processing. QA/QC activities for the 2032 emissions were conducted for the 4 km domain using EPA's 2022v1 2026 emissions as a reference. The 2032 QA/QC activities included, but were not limited to the following:

- Tabular comparisons of total 2032 NO_X and VOC emissions in the NMED 4 km domain by source sector.
- Spatial maps of 2032 emissions within the NMED 4 km domain by source sector.
- Comparisons of emissions totals during each stage of SMOKE processing to ensure that no emissions were lost or gained during processing.
- Independent QA/QC review of the 2032 emissions comparisons by Ramboll staff not directly involved in the emissions development and modeling.

4.0 DESIGN OF THE CAMX 2022V2 AND 2032 OZONE SOURCE APPORTIONMENT MODELING

During Phase II FY2026 of the NMED regional ozone source apportionment modeling study, two types of ozone source apportionment modeling were conducted using the CAMx 2022v2 12/4 km modeling platform:

1. Local Source: The Local Source ozone source apportionment modeling examined the contributions of Source Categories in New Mexico and the Permian Basin portion of Texas to estimated ozone concentrations and ozone Design Values for the 2022 and 2032 emission scenarios; and
2. State-Specific: The State-Specific ozone source apportionment modeling estimated the contributions of western states and in-domain Mexico anthropogenic emissions to 2032 ozone concentrations and ozone Design Values in New Mexico.

4.1 APCA Version of Source Apportionment

CAMx includes two ozone source apportionment probing tools: the Ozone Source Apportionment Technology (OSAT) and the Anthropogenic Precursor Culpability Assessment (APCA). Both versions used reactive tracers or tagged species that run in parallel to the CAMx host model extracting information on ozone formation and destruction during the CAMx simulation and assigning it to user selected Source Groups. Source Groups are typically defined as the intersection of Source Categories and Source Regions (e.g., O&G emissions from the New Mexico portion of the Permian Basin).

OSAT was the first ozone source apportionment tool implemented in CAMx and is briefly described in this section with more details provided in the CAMx user's guide (Ramboll, 2024). For each user-selected Source Group (i), there are 10 reactive tracers associated with the Source Group that include NO_X (N_i) and VOC emissions (V_i), ozone attributed to the Source Group that are formed under more NO_X-sensitive ($O3N_i$) or VOC-sensitive ($O3V_i$) ozone formation conditions, and numerous intermediate species. In each CAMx grid cell and at each numerical integration time step of the model simulation, ozone formed in the grid cell (ΔO3) is allocated to Source Groups based on OSAT's determination whether the ozone was formed under more NO_X-sensitive or VOC-sensitive conditions and the relative amount of the limiting precursor from each Source Group contributing to the total concentration in the grid cell (e.g., under NO_X-sensitive conditions: $O3N_i = O3N_i + N_i / \Sigma N_i$).

When OSAT was first introduced in CAMx during the Ozone Transport Assessment Group (OTAG) eastern states regional ozone study, it allocated a lot of ozone concentrations to biogenic emissions as on a regional scale biogenic VOC emissions are much greater than anthropogenic VOC emissions. There were concerns that OSAT did not provide control strategy relevant results since biogenic emission cannot be controlled. This led to the development of the APCA variant of the CAMx ozone source apportionment probing tool that only allocates ozone formed to the Biogenic (or Natural) Source Category when the ozone formed was due to the interactions of Biogenic VOC and Biogenic NO_X emissions. For example, if ozone was formed due to the interaction of Biogenic VOC and Anthropogenic NO_X emissions under VOC-sensitive conditions, a case OSAT would assign the ozone formed to the Biogenic Source Group O3V, APCA redirects the ozone formed to the Anthropogenic Source Group O3N.

For both the NMED Local Source and State Specific ozone source apportionment modeling, the APCA version of the CAMx ozone source apportionment probing tool was used. APCA is also used in EPA's transport rules. When using APCA, the first Source Category must be the Biogenic/Natural Source Category.

4.2 Local Source Ozone Source Apportionment Modeling Approach

The CAMx Local Source APCA ozone source apportionment modeling used the CAMx 2022v2 12/4 km modeling platform and four Source Regions and 10 Source Categories. Since contributions due to Initial Concentration (IC) and Boundary Conditions (BC) always have to be tracked, this results in separate ozone contributions due to 42 Source Groups (42 = 4 x 10 + 2) in the CAMx Local Source ozone source apportionment modeling. Tables 4-1 and 4-2 identify the 4 Source Regions and 10 Source Categories used in the Local Source ozone source apportionment modeling with Figure 4-1 showing a map of the 4 Source Regions.

Table 4-1. Four Source Regions used in the CAMx Local Source ozone source apportionment modeling.

Name	Source Region
NMPB	New Mexico Permian Basin
NMRE	Remainder New Mexico
TXPB	Texas Permian Basin
REMD	Remainder Domain

Table 4-2. Ten Source Categories used in the CAMx Local Source ozone source apportionment modeling.

Name	Source Category
NAT	Natural (Biogenic plus Lightning NOx [LNOx])
FIR	Fires
OGD	Pre-Production Oil and Gas
OGP	Production Oil and Gas
OGM	Midstream Oil and Gas
EGU	Electrical Generating Unit Point Source
NEG	Non-EGU Point Source
ONR	On-Road Mobile
NON	Non-Road Mobile
REA	Remainder Anthropogenic

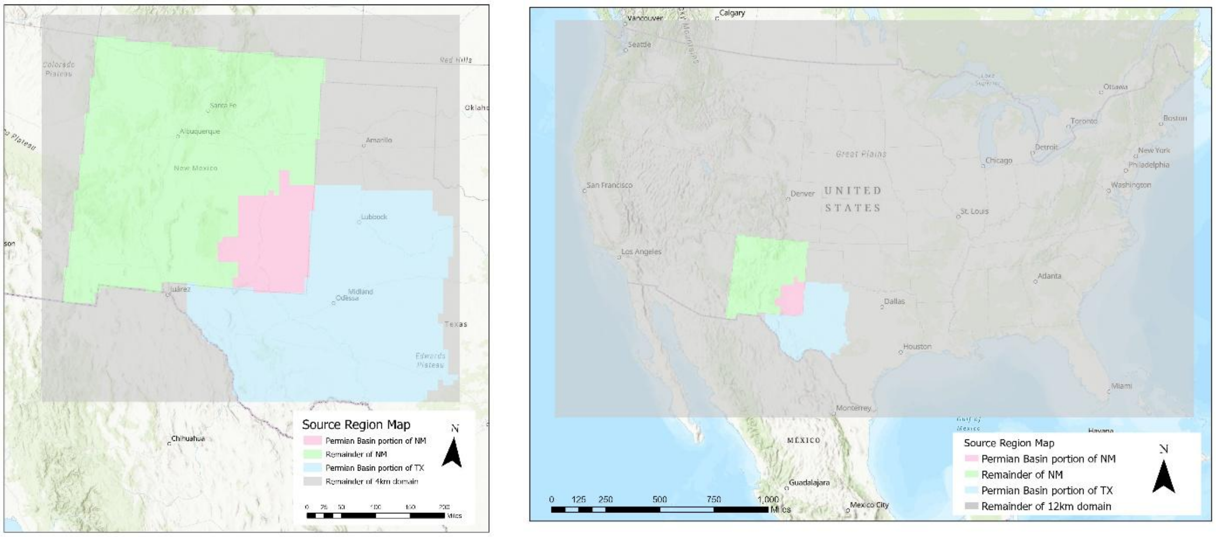

Figure 4-1. Four Source Regions used in the CAMx Local Source ozone source apportionment modeling defined for the New Mexico 4 km domain (left) and 12 km CONUS domain (right).

The CAMx Local Source APCA ozone source apportionment modeling was conducted for both the 2022 and 2032 emission scenarios.

The NMED Phase I ozone source apportionment modeling using the CAMx 2022v1 12 km modeling platform found that elevated ozone concentrations in southern New Mexico during May and early June period of the summer 2022 were dominated by contributions from BCs. In addition, there were impacts from the Calf Canyon/Hermits Peak wildfire (April 6 – August 22, 2022) and the Black (Water) wildfire (May 13 – July 27, 2022) that were more intense in May and June, which were the two largest New Mexico wildfires in modern history. Consequentially, the Phase I ozone source apportionment modeling for May 2022 did not provide very useful information on the contributions of local sources to ozone in New Mexico. Thus, the Phase II Local Source 2022 and 2032 ozone source apportionment simulation was performed for the June 1 through August 15, 2022 period with June 1 through 9, 2022 used as spin-up days to initialize the model concentrations.

4.3 State Specific Ozone Source Apportionment Modeling

The State Specific ozone source apportionment simulation was run in a similar fashion EPA uses for its transport rules (e.g., Good Neighbor Rule for the 2015 ozone NAAQS[15]). The State Specific ozone source apportionment modeling was run with 11 Source Regions consisting of 9 western States, the portion of Mexico in the 12/4 km domain, and the remainder of the 12 km domain as shown in Table 4-3 and Figure 4-2.

Three Source Categories were used in the State Specific ozone source apportionment modeling: Biogenic, Fires plus lightning NO_X (LNOx), and Anthropogenic (Table 4-4). Note that the first Source Category in the Local Source (Biogenic + LNOx) and State Specific (Biogenic alone) are a little different in order for the State Specific APCA run to be configured the same way that EPA runs their ozone transport modeling.

[15] https://www.epa.gov/Cross-State-Air-Pollution/interstate-transport-2015-ozone-naaqs

The CAMx 12/4 km State Specific APCA ozone source apportionment modeling was conducted for the future year 2032 emissions scenario.

Table 4-3. Eleven Source Regions used in the CAMx State Specific ozone source apportionment modeling.

Name	Source Region
AZ	Arizona
CA	California
CO	Colorado
KS	Kansas
NM	New Mexico
NV	Nevada
OK	Oklahoma
TX	Texas
UT	Utah
MX	Mexico
REM	Remainder 12 km domain

Table 4-4. Three Source Categories used in the CAMx State Specific ozone source apportionment modeling.

Name	Source Category
BIO	Biogenic
FIL	Fires plus LNOx
ANT	Anthropogenic

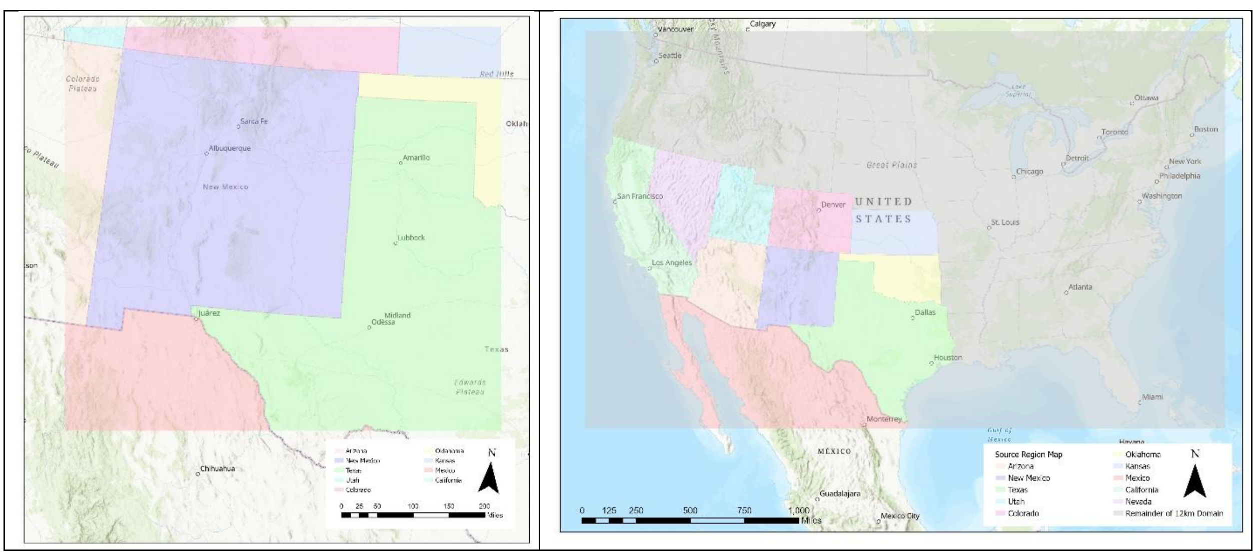

Figure 4-2. Eleven Source Regions used in the CAMx State Specific ozone source apportionment modeling defined for the New Mexico 4 km domain (left) and 12 km CONUS domain (right).

Note that the original intent of the State Specific ozone source apportionment modeling was to also tag the BCs due to international anthropogenic emissions as a separate Source Group. Although EPA has performed a 2022 HCMAQ global chemistry model simulation with no international anthropogenic emissions, the results were not released in time for this study.

The State Specific ozone source apportionment modeling was conducted for May 1 through August 15, 2022 period.

5.0 OZONE DESIGN VALUE PROJECTIONS

This Chapter discusses the procedures and results of the base year and future year ozone Design Value calculations.

5.1 Procedures for Projecting Future Year Ozone DVFS

Estimates of 2032 future year ozone Design Values (DVF_{2032}) were made following EPA guidance (EPA, 2018a) that recommends using PGM modeling results in a relative manner to scale the observed base year ozone Design Value (DVB). The model-derived scaling factors are called Relative Response Factors (RRFs) and are the ratio of the modeled future year (2032) to modeled base year (2022) MDA8 ozone concentrations averaged over the top 10 modeled base year MDA8 ozone days near the monitor (i.e., the highest modeled MDA8 ozone concentration within a 3x3 array of grid cells centered on the monitoring site location):

$$RRF = \Sigma \text{ Model-Ozone}_{2032} / \Sigma \text{ Model-Ozone}_{2022}$$

The observed base year DVB is the average of three-years of ozone Design Values centered on the 2022 base year (i.e., 2020-2024 in this case):

$$DVB_{2020\text{-}2024} = (DV_{2020\text{-}2022} + DV_{2021\text{-}2023} + DV_{2022\text{-}2024}) / 3$$

$$DVF_{2032} = RRF \times DVB_{2020\text{-}2024}$$

The RRF requires that the modeled base year MDA8 ozone concentrations be above 60 ppb. If there are less than 5 days with modeled base year MDA8 ozone above 60 ppb, no future year ozone DVF is calculated.

EPA has codified their recommended approach for making Design Value projection in the Software for the Modeled Attainment Test – Community Edition (SMAT-CE).

SMAT-CE also has an Unmonitored Area Analysis (UAA) that interpolates the observed 2020-2024 ozone DVB across the domain and makes future year ozone projections in each grid cell using similar procedures as used at the monitoring sites. The SMAT-CE UAA ozone DVB interpolation can be performed using gradient adjusted (GA) interpolation, where the spatial interpolation uses the CAMx MDA8 ozone concentration gradients in the interpolation, or without any gradient adjustments (NoGA) in the UAA interpolation.

5.2 Four Methods for Making 2032 Ozone DVF Projections

2032 ozone DVF projections were made four ways. Two of the methods were conventional 2032 ozone DVF projections using SMAT-CE and differ in the days from the CAMx 2022 and 2032 simulations whose MDA8 ozone concentration results are used in making the 2032 ozone DVF projections: one using the full May – October 2022 modeling period and the other using CAMx results from June 10 – August 15, 2022 episode period that was used in the CAMx 2022 and 2032 Local Source ozone source apportionment modeling.

The third and fourth ozone DVF projection methods account for the CAMx 2022 base case model performance issues that found that the observed O&G signature VOC species (ethane and propane) were underestimated by approximately a factor of 5, which is believed to be due to missing O&G emissions, and led to underestimation of the observed elevated ozone concentrations in the Permian Basin. These two alternative approaches for projecting 2032 ozone DVFs adapts an approach developed in Coordinate Research Council (CRC) Project No. A-112: "Relative Reduction Factors Using Anthropogenic Ozone Increments" (Ramboll, 2018; Dunker, Koo and Yarwood, 2019). In the original CRC A-112 alternative future year ozone DVF projection approach, background ozone is subtracted out of the MDA8 ozone modeling results used in making the RRFs as well as the base year ozone DVB and the remaining incremental ozone DVB is projected to the future year and the ozone background is added back in to the projected incremental ozone DVF to make the future year total ozone DVF projection as shown in Figure 5-1.

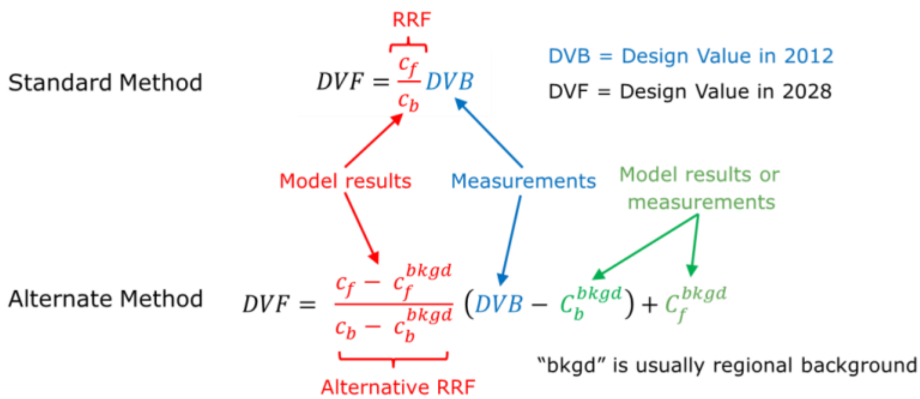

Figure 5-1. Alternative future year ozone DVF project approach using anthropogenic emissions ozone increment RRFs developed in CRC Project No. 112.

The CRC Project A-112 projection approach was adapted by using the CAMx 2022 and 2032 Local Source ozone source apportionment results to split the observed 2020-2024 ozone DVB at the three New Mexico Permian Basin monitoring sites into a Local (DVB_{Local}) and Non-Local ($DVB_{Non\text{-}Local}$) components:

$$2020\text{-}2024 \text{ ozone DVB} = DVB_{Local} + DVB_{Non\text{-}Local}$$

The Local DVB component is the ozone contribution due to O&G emissions in the New Mexico and Texas portions of the Permian Basin (PB O&G). The CAMx 2022 and 2032 Local Source ozone source apportionment simulation ozone contributions due to the PB O&G on the 10 SMAT-CE days are used to develop the RRF for the Local DVB Component. Similarly, the CAMx 2022 and 2032 Local Source ozone contributions for all other Source Groups (i.e., not PB O&G) are used to develop the RRF for the Non-Local component of the DVB.

$$2032 \text{ Ozone DVF} = RRF_{Local} \times DVB_{Local} + RRF_{Non\text{-}Local} \times DVB_{Non\text{-}Local}$$

The two alternative 2032 ozone DVF projection approaches account for the CAMx underestimation of ozone in the Permian Basin due to missing O&G emissions by adding the difference in the observed and modeled total MDA8 ozone (i.e., the ozone underestimation bias) to the PB O&G ozone contributions. The two alternative 2032 ozone DVF projection approaches differ in how they account for the ozone underestimation bias and split the 2020-2024 ozone DVB into the DVB_{Local} and $DVB_{Non\text{-}Local}$ components:

- Alternative#1 - 2022 SMAT Days MDA8 Ozone to Define $DVB_{Non\text{-}Local}$: The CAMx 2022 Local Source ozone source apportionment modeling MDA8 ozone contributions from all of the Non-Local Source Groups (i.e., not the NMPB and TXPB Source Regions O&G Source Categories) averaged across the 10 SMAT days is used to define the

$DVB_{Non-Local}$ and the DVB_{Local} is obtained as its difference with the observed 2020-2024 ozone DVB.

- Alternative#2 – MPE Adjusted DVB_{Local}: The DVB_{Local} is defined as the CAMx 2022 Local Source ozone source apportionment modeling PB O&G Source Groups MDA8 ozone contribution averaged over the 10 SMAT days plus the difference in the average observed and average modeled MDA8 ozone concentrations over the 10 highest MDA8 ozone days in 2022 (unmatched in time). The $DVB_{Non-Local}$ is then defined as the difference of the DVB_{Local} with the observed 2020-2024 ozone DVB.

5.3 Projected 2032 Ozone DVF at Monitoring Sites

Projected 2032 ozone DVFs were made at monitoring sites using two periods of CAMx 2022 and 2032 modeling results (full modeling period and little over 2 month period) using SMAT-CE. The projected 2032 ozone DVFs using CAMx results for the full modeling period are shown in Table 5-1 that displays the observed base year 2020-2024 ozone DVB and projected 2032 ozone DVF using SMAT-CE. Also shown in Table 5-1 is the Relative Response Factor (RRF), the number of days used in the RRF, and the lowest 2022 MDA8 ozone used in the RRF. There are 7 New Mexico monitoring sites with observed 2020-2024 ozone DVBs that exceed the 70 ppb 2015 ozone NAAQS with four of them also exceeding the 75 ppb 2008 ozone NAAQS, two in Edy County in the Permian Basin and two in Doña Ana County. The projected 2032 ozone DVF using the CAMx results for the full period still exceed the 2008 ozone NAAQS at the two New Mexico Eddy County sites and exceed the 2015 NAAQS at two sites in Doña Ana County but are below the 2015 ozone NAAQS at the other three sites whose ozone DVB were between the 2015 and 2008 ozone NAAQS.

Table 5-1. Observed 2020-2024 base year ozone DVB and projected 2032 ozone DVF using SMAT-CE and CAMx 2022v2/2032 modeling results for the full May – October 2022 modeling period.

Full Period		2020-24	2032						
Name	Site ID	DVB	DVF	RRF	Low	#Day	State	County	Region
Carlsbad Caverns	350150010	78.3	77.0	0.9843	64	10	New Mexico	Eddy	NM-PB
Carlsbad City	350151005	78.0	76.4	0.9803	65	10	New Mexico	Eddy	NM-PB
Hobbs	350250008	69.7	68.3	0.9811	62	10	New Mexico	Lea	NM-PB
La Union	350130008	76.0	73.3	0.9647	63	10	New Mexico	Doña Ana	NM-S
Chaparral	350130020	70.3	67.6	0.9626	61	10	New Mexico	Doña Ana	NM-S
Desert View	350130021	77.3	74.6	0.9663	63	10	New Mexico	Doña Ana	NM-S
Santa Teresa	350130022	73.5	70.7	0.9627	63	10	New Mexico	Doña Ana	NM-S
Solano	350130023	67.3	65.3	0.9706	62	10	New Mexico	Doña Ana	NM-S
Ivanhoe	481410029	64.3	62.0	0.9657	63	10	Texas	El Paso	TX-EP
El Paso Chamizal	481410044	69.0	67.0	0.9719	63	10	Texas	El Paso	TX-EP
Ascarate Park SE	481410055	70.0	68.4	0.9777	62	10	Texas	El Paso	TX-EP
Socorro Hueco	481410057	71.7	69.6	0.9718	64	10	Texas	El Paso	TX-EP
Skyline Park	481410058	70.3	67.6	0.9623	63	10	Texas	El Paso	TX-EP
Del Norte	350010023	69.7	67.2	0.9642	62	10	New Mexico	Bernalillo	NM-Cen
South Valley	350010029	66.0	64.1	0.9715	62	10	New Mexico	Bernalillo	NM-Cen
Foot Hills	350011012	72.3	69.1	0.9559	62	10	New Mexico	Bernalillo	NM-Cen
Bernalillo	350431001	68.3	65.4	0.9577	62	10	New Mexico	Sandoval	NM-Cen
Santa Fe	350490021	66.0	64.1	0.9717	60	9	New Mexico	Santa Fe	NM-Cen
Los Lunas	350610008	64.7	62.9	0.9727	61	10	New Mexico	Valencia	NM-Cen
Coyote	350390026	63.3	61.7	0.9760	61	10	New Mexico	Rio Arriba	NM-SSJ
Bloomfield	350450009	65.3	62.0	0.9497	62	10	New Mexico	San Juan	NM-SSJ
Navajo Lake	350450018	69.3	65.5	0.9453	63	10	New Mexico	San Juan	NM-SSJ
Chaco	350450020	67.0	65.1	0.9722	61	10	New Mexico	San Juan	NM-SSJ
Sub Station	350451005	67.0	64.4	0.9615	62	10	New Mexico	San Juan	NM-SSJ
Shamrock	80671004	64.0	61.2	0.9570	62	10	Colorado	La Plata	CO-NSJ
Ignacio	80677001	66.3	62.3	0.9410	63	10	Colorado	La Plata	CO-NSJ
Bondad	80677003	66.0	62.7	0.9506	63	10	Colorado	La Plata	CO-NSJ
Cortez	80830006	62.3	60.9	0.9782	60	10	Colorado	Montezuma	CO-NSJ
Mesa Verde NP	80830101	64.7	62.8	0.9713	61	10	Colorado	Montezuma	CO-NSJ

Table 5-3 is similar to Table 5-2 only the 2032 ozone DVF projections are made using SMAT-CE with CAMx modeling results for just the June 10 through August 15, 2022 episode, the same period used in the 2022/2032 Local Source ozone source apportionment modeling. As in Table 5-2, there are seven sites whose base year 2020-2024 ozone DVB exceed the 70 ppb ozone NAAQS with four of these sites also exceeding the 75 ppb 2008 NAAQS. The same four sites have projected 2032 ozone DVF exceeding the 70 ppb NAAQS in Table 5-3 as in Table 5-2, only the two Permian Basin sites that exceeded the 75 ppb NAAQS in Table 5-2 using the May-October CAMx modeling results (77.0 and 76.4 ppb) are below the 75 ppb NAAQS in Table 5-3 using the June 10 – August 15, 2022 CAMx modeling results (75.1 and 74.3 ppb).

Table 5-2. Observed 2020-2024 base year ozone DVB and projected 2032 ozone DVF using SMAT-CE and CAMx 2022v2/2032 modeling results for the June 10 – August 15, 2022 episode.

Jun-Aug		2020-24	2032						
Name	**Site ID**	**DVB**	**DVF**	**RRF**	**Low**	**#Day**	**State**	**County**	**Region**
Carlsbad Caverns	350150010	78.3	75.1	0.9595	60	10	New Mexico	Eddy	NM-PB
Carlsbad City	350151005	78.0	74.3	0.9532	61	10	New Mexico	Eddy	NM-PB
Hobbs	350250008	69.7	65.9	0.9469	60	5	New Mexico	Lea	NM-PB
La Union	350130008	76.0	71.4	0.9397	62	10	New Mexico	Doña Ana	NM-S
Chaparral	350130020	70.3	65.6	0.9341	60	7	New Mexico	Doña Ana	NM-S
Desert View	350130021	77.3	72.7	0.9417	62	10	New Mexico	Doña Ana	NM-S
Santa Teresa	350130022	73.5	68.5	0.9326	61	10	New Mexico	Doña Ana	NM-S
Solano	350130023	67.3	64.2	0.9549	60	5	New Mexico	Doña Ana	NM-S
Ivanhoe	481410029	64.3	61.7	0.9608	61	10	Texas	El Paso	TX-EP
El Paso Chamizal	481410044	69.0	65.7	0.9532	60	10	Texas	El Paso	TX-EP
Ascarate Park SE	481410055	70.0	66.9	0.9559	61	10	Texas	El Paso	TX-EP
Socorro Hueco	481410057	71.7	68.4	0.9546	61	10	Texas	El Paso	TX-EP
Skyline Park	481410058	70.3	65.8	0.9368	61	10	Texas	El Paso	TX-EP
Del Norte	350010023	69.7	66.4	0.9527	60	10	New Mexico	Bernalillo	NM-Cen
South Valley	350010029	66.0	63.2	0.958	60	6	New Mexico	Bernalillo	NM-Cen
Foot Hills	350011012	72.3	68.6	0.9495	61	10	New Mexico	Bernalillo	NM-Cen
Bernalillo	350431001	68.3	65.3	0.957	61	10	New Mexico	Sandoval	NM-Cen
Bloomfield	350450009	65.3	62.8	0.9629	61	10	New Mexico	San Juan	NM-SSJ
Navajo Lake	350450018	69.3	66.0	0.9533	60	10	New Mexico	San Juan	NM-SSJ
Sub Station	350451005	67.0	65.3	0.9754	60	8	New Mexico	San Juan	NM-SSJ
Shamrock	80671004	64.0	60.9	0.952	60	9	Colorado	La Plata	CO-NSJ
Ignacio	80677001	66.3	61.6	0.9305	61	10	Colorado	La Plata	CO-NSJ
Bondad	80677003	66.0	61.3	0.9298	62	10	Colorado	La Plata	CO-NSJ
Cortez	80830006	62.3	61.1	0.9813	60	6	Colorado	Montezuma	CO-NSJ

The reductions in the projected 2032 DVF using CAMx results for the 10 SMAT days from the June 10 – August 15 episode are greater and more responsive than when the 10 SMAT days from the full May – October modeling period are used. For example, the observed 2020-2024 ozone DVB at Carlsbad City was 78.0 ppb and the projected ozone DVF was reduced 1.6 ppb (76.4 ppb) using CAMx results for the full episode but when CAMx results from the June 10 – August 15 episode are used the DVF it reduced 3.7 ppb (74.3 ppb), more than double the reduction than when CAMx results for the full modeling period are used. As shown in the Phase I CAMx 2022v1 12 km source apportionment modeling (Ramboll, 2025a), the May and early June 2022 periods have higher contributions due to Boundary Condition (BCs) than high MDA8 ozone days later in 2022. The BCs, that define the incoming concentrations through the lateral boundaries of the 12 km CONUS domain, remain unchanged between 2022 and 2032 simulations.

Figure 5-2 shows the ozone contributions at Carlsbad City for the 10 SMAT days from the CAMx 2022v1 12 km Phase I simulation of the full modeling period and the ozone contribution results from the CAMx 2022v2 12/4 Local Source simulation of the June 10 – August 15, 2022 episode. For the Phase I full modeling period, the BC contribution to 2025 MDA8 ozone on the 4 SMAT days in May range from 80% to 95% while the BC contribution on the other 6 SMAT days later in the summer range from 35% to 62%. When averaged across the 10 SMAT days BC's contribute 66% of the ozone in the Phase I full modeling period simulation versus 54% of the ozone in the Phase II June 10 – August 15 episode modeling.

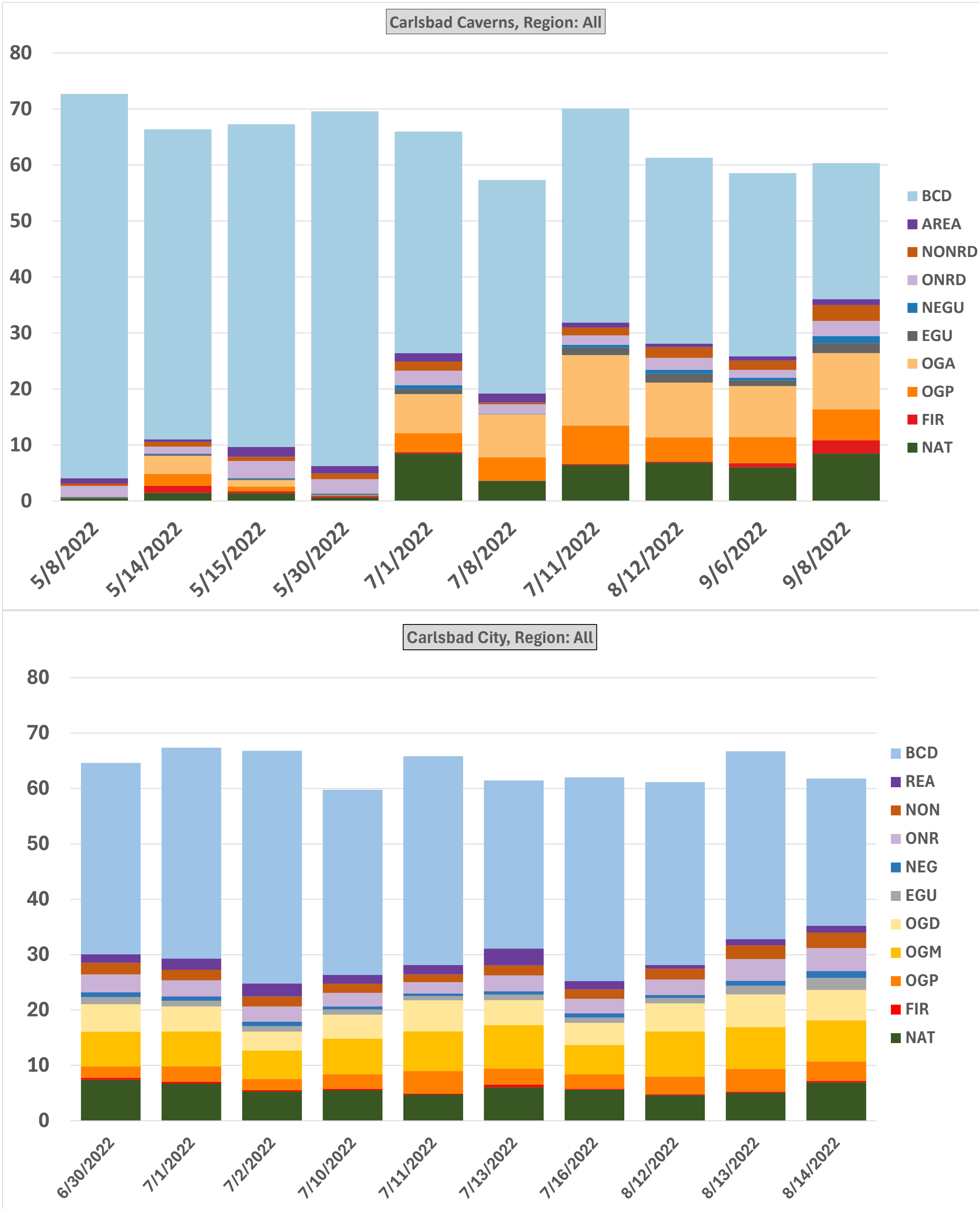

Figure 5-2. Comparison of ozone contribution to MDA8 ozone concentrations at Carlsbad City for 10 SMAT days using 2026v1 ozone source apportionment for full modeling period from CAMX 2022v1 Phase I modeling and 2022v2 ozone source apportionment results using June 10 – August 15, 2022 episode modeling from CAMx 2022v2 Phase II results.

5.3.1 2032 Ozone DVF Projections at New Mexico Permian Basin Sites using Alternative DVF Projection Approaches

Table 5-3 displays the projected 2032 ozone DVFs at the three New Mexico Permian Basin monitoring sites using the two alternative 2032 ozone DVF projection approaches that use the Local Source ozone source apportionment results to separately project the Local Permian Basin and the Non-Local Permian Basin 2020-2024 ozone DVB increments. For both alternatives, the RRF_{Local} (-6.5%) at Carlsbad City is more responsive (i.e., larger relative reduction) than the $RRF_{Non\text{-}Local}$ (-4.1% and -4.6%). At Carlsbad Caverns, on the other hand, the opposite is true with the RRF_{Local} (-3.3%) being less responsive than the $RRF_{Non\text{-}Local}$ (-4.2% and -4.1%). At Hobbs, the RRF_{Local} (-8.1%) is almost twice as responsive as the $RRF_{Non\text{-}Local}$ (-4.6% and -4.9%). Ozone at Hobbs has a higher influence from O&G emissions in TXPB region and there are greater O&G emissions reductions in the Texas portion of the Permian Basin due to lower growth factors between 2022 and 2032 (e.g., 0.92 for oil production) than in the New Mexico portion of the Permian Basin (e.g., 1.34 for Eddy County oil production).

Table 5-3. Results of the alternative future year 2032 ozone DVF projection approach that separately projects the Permian Basin local DVB_{Local} and non-local $DVB_{Non\text{-}Local}$ ozone increments to obtain a projected future year 2032 ozone DVF.

Monitoring Site	Alternative#1 SMAT MDA8 Ozone			Alternative#2 MPE Top 10 MDA8		
	Total	Local	Non-Local	Total	Local	Non-Local
Carlsbad City						
2022-2024 DVB	78.0	26.86	51.14	78.0	24.10	53.90
RRF		0.9346	0.9589		0.9346	0.9541
2032 DVF	74.14	25.10	49.04	73.95	22.52	51.43
Carlsbad Caverns						
2022-2024 DVB	78.3	26.58	51.72	78.3	24.83	53.47
RRF		0.9671	0.9579		0.9671	0.9595
2032 DVF	75.25	25.70	49.54	75.31	24.01	51.31
Hobbs						
2022-2024 DVB	69.7	16.91	52.79	69.7	12.07	57.63
RRF		0.9191	0.9545		0.9191	0.9507
2032 DVF	65.93	15.54	50.39	65.88	11.09	54.79

Table 5-4 Compares the projected 2032 ozone DVF at the three New Mexico Permian Basin monitoring sites using the four projection methods. As seen in Tables 5-1 and 5-2, the SMAT-CE using the full episode is the stiffest providing the least amount of ozone reduction between 2022 and 2032. At Carlsbad City, the two alternative projection approaches 2032 DVF are very similar (74.1 ppb and 74.0 ppb) and provide ~1 ppb more reduction than SMAT-CE (75.1 ppb) using the CAMx results for the June 10 – August 15 episode. The reverses is true for Carlsbad Caverns where the alternative projection approach DVF (75.3 ppb) is 1 ppb higher than SMAT-CE (74.3 ppb) using the June 10 – August 15 CAMx results. And at Hobbs projected 2032 ozone DVF is 65.9 using SMAT-CE with episode results or the two alternative approaches.

Table 5-4. Observed 2020-2024 ozone DVB and projected 2032 ozone DVF at the three New Mexico Permian Basin monitoring sites using the four projection approaches.

Monitoring Site	Observed 2020-2024 Ozone DVB	SMAT-CE Full Model Period	SMAT-CE June 10 - August 15	Alternative#1 10 SMAT Days $DVB_{Non-Local}$	Alternatuve#2 Adjust Ozone MPE DVB_{Local}
Carlsbad City	78.0	77.0	75.1	74.1	74.0
Carlsbad Caverns	78.3	76.4	74.3	75.3	75.3
Hobbs	69.7	68.3	65.9	65.9	65.9

5.4 Ozone Projections Across the New Mexico Domain Using the SMAT-CE UAA

The SMAT-CE Unmonitored Area Analysis (UAA) was used to spatially interpolate the observed 2020-2024 ozone DVBs across the New Mexico 4 km domain and project 2032 ozone DVFs across the New Mexico 4 km domain four ways:

1. Using CAMx results for the full May – October 2022 episode and the UAA gradient adjusted (GA) interpolation approach.
2. Using CAMx results for the full May – October 2022 episode and without the UAA gradient adjusted (NoGA) interpolation approach.
3. Using CAMx results for the abbreviated June 10-August 15, 2022 Local Source episode period with the UAA gradient adjusted (GA) interpolation approach.
4. Using CAMx results for the abbreviated June 10-August 15, 2022 Local Source episode period without the UAA gradient adjusted (NoGA) interpolation approach.

Figure 5-3 displays the spatial distribution of the 2020-2024 ozone DVB across the New Mexico 4 km domain using the SMAT-CE UAA interpolation with and without gradient adjustments from the CAMx full modeling period and June 10 – August 15, 2022 episode. When the UAA interpolation with NoGA is used the spatial distribution of the 2020-2024 ozone DVB is the same whether the full modeling period or episodic CAMx results are used as the CAMx results are not used in the NoGA spatial interpolation. When using the UAA NoGA interpolation procedure, the high measured 2020-2024 ozone DVBs at monitors near high emission areas (e.g., Permian Basin, El Paso-Juarez, etc.) can be interpolated into areas with low emissions and lower ozone because of a lack of monitoring sites in the cleaner areas.

The interpolated 2020-2024 ozone DVB using the UAA GA interpolation approach produce somewhat different spatial fields when the full modeling period CAMx results are used the CAMx interpolates much wider areas of elevated ozone DVBs than when the June-August episode results are used. This is due to the CAMx high modeled ozone concentrations in May and early June that are due to BCs so elevated ozone concentrations are more widespread than when the June-August episode CAMx ozone results are used that has higher relative contributions from in-domain emission sources. The full modeling period UAA GA DVB interpolation also see more pronounced effects of modeled ozone due to the Calf Canyon/Hermits Peak and Black (Water) wildfires whose ozone impacts may or may not be realistic as there are no monitoring sites in those regions.

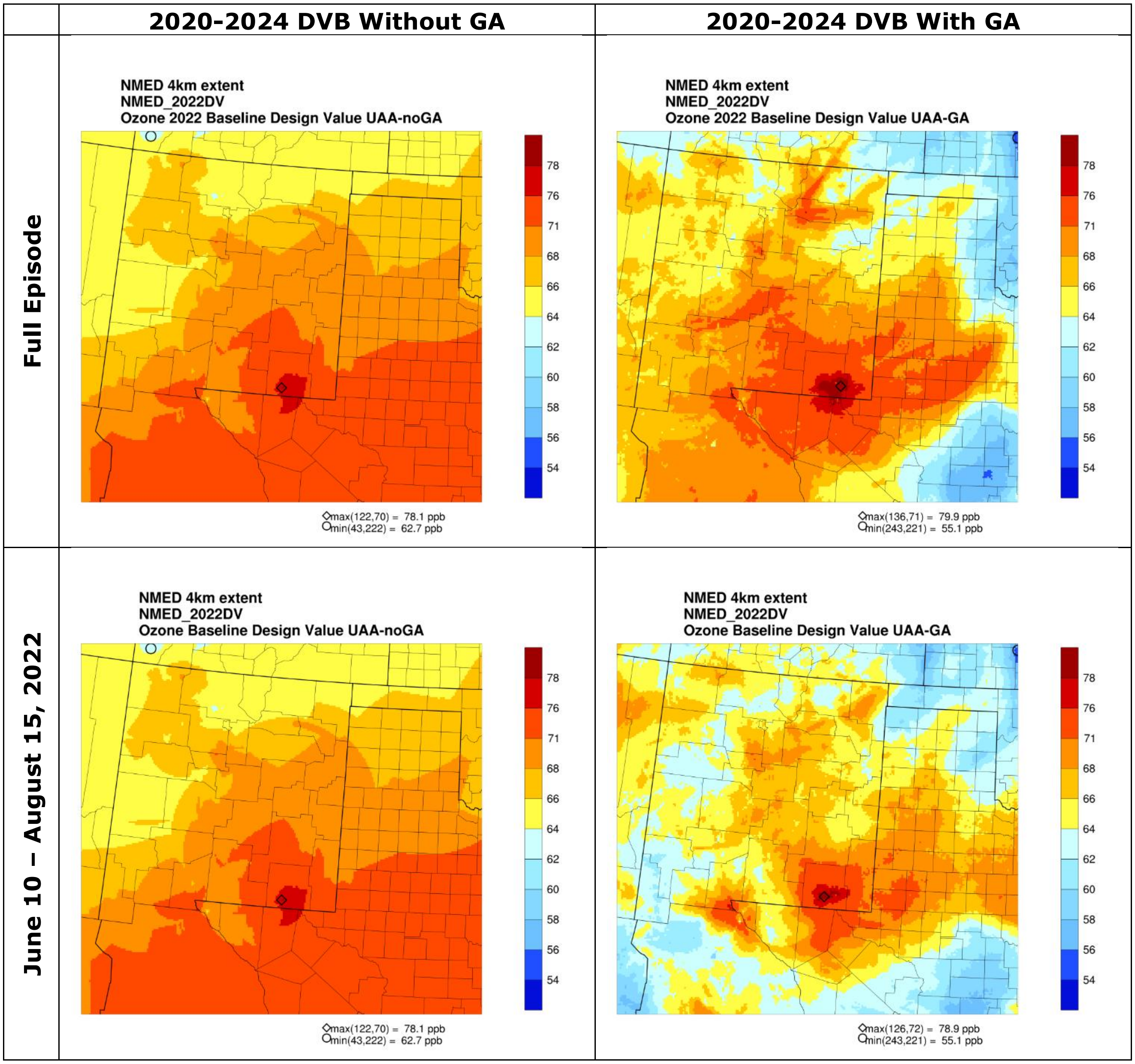

Figure 5-3. SMAT-CE spatially interpolated 2020-2024 ozone DVB with (GA; right) and without (NoGA; left) using gradient adjustments from CAMx ozone fields for the full May – October 2022 modeling period (top) and the June 10 – August 15, 2022 episode (bottom).

Figure 5-4 displays the projected 2032 ozone DVFs for the full modeling period and the episodic CAMx results and using SMAT-CE GA and NoGA interpolation procedures. As seen in the 2032 ozone DVF projections at the monitor9ign sites, using the episode CAMx results in lower projected 2032 ozone DVFs than using the CAMx full modeling period results. For all four scenarios, the highest 2032 ozone DVF in the 4 km New Mexico domain occurs in the Permian Basin near Carlsbad. The area where the projected 2032 ozone DVF exceeds the 2015 ozone NAAQS varies by the four projection approaches from most of the New Mexico Permian Basin stretching south into Texas and Mexico in the full modeling period NoGA UAA approach (Figure 5-4, top left) to just southern Eddy County with a little into Lea County in the episodic GA approach (Figure 5-4, bottom right).

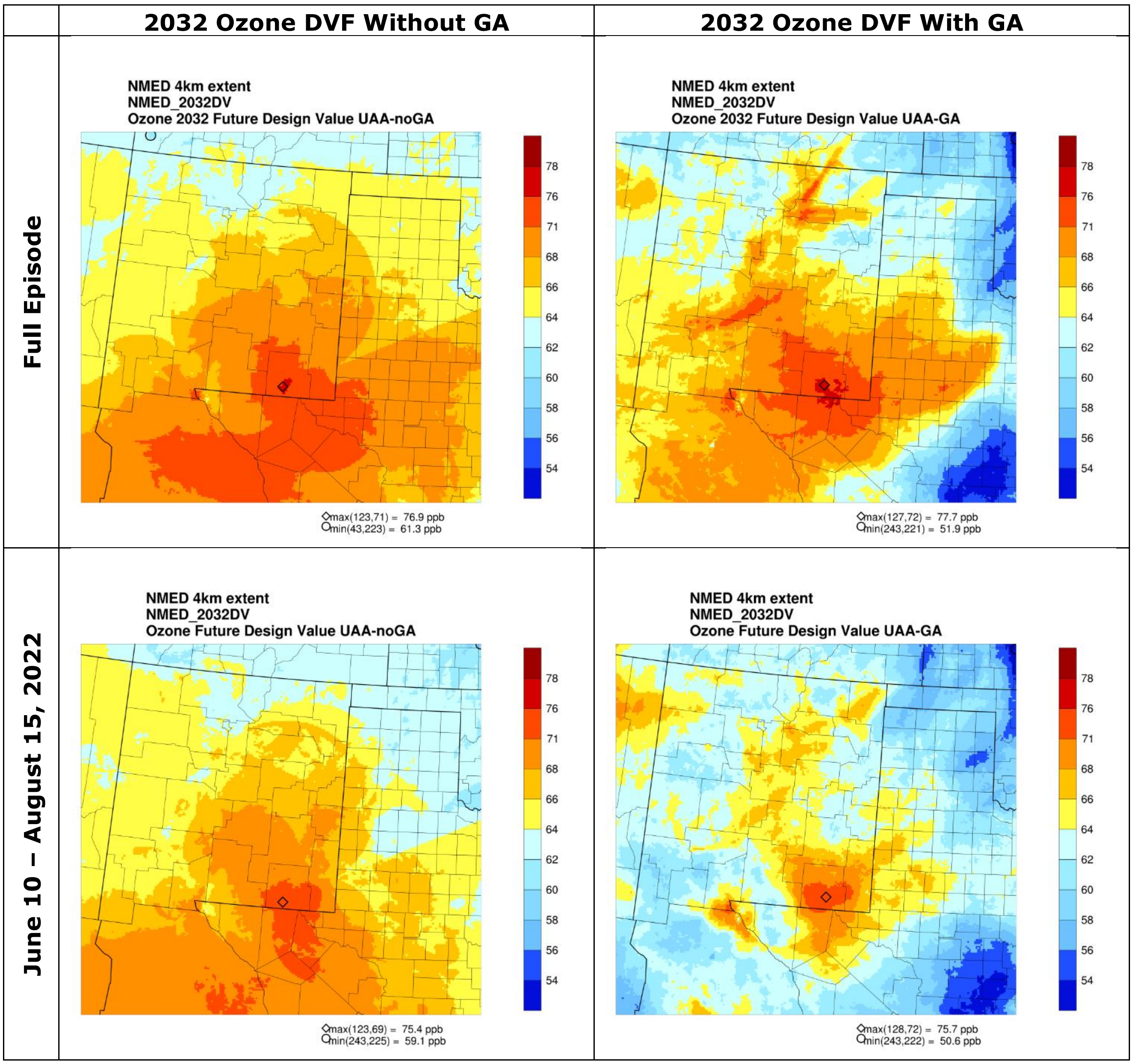

Figure 5-4. Projected 2032 ozone DVF with (GA; right) and without (NoGA; left) using gradient adjustments from CAMx ozone fields for the full May – October 2022 modeling period (top) and the June 10 – August 15, 2022 episode (bottom).

6.0 CAMX 2022 AND 2032 LOCAL SOURCE OZONE SOURCE APPORTIONMENT MODELING

In this chapter, we present the 2022 and 2032 Local Source ozone source apportionment modeling results using the CAMx 2022v2 12/4 km modeling platform.

6.1 Local Source Contributions to Ozone Design Values Across the New Mexico 4 km Modeling Domain

SMAT-CE UAA was run using CAMx output for all sources and CAMx output with ozone contributions from the Local Source ozone source apportionment Source Groups removed. The differences in these two SMAT-CE UAA runs provide the contributions of selected Source Group to the spatial distribution of base year ozone DVBs and projected future year 2032 ozone DVFs. Initial tests were run doing the Source Group ozone Design Value difference plots with and without the UAA gradient adjustments and found no material differences in the GA and NoGA difference plots, therefore the SMAT-CE UAA Source Group difference plots are presented for just the UAA GA approach. Since the CAMx 2022 and 2032 Local Source ozone source apportionment was run for the June-August episodic period then the base 2020-2024 ozone DVB and projected 2032 ozone DVF spatial distributions correspond to the SMAT-CE UAA GA using the CAMx June 10 – August 15, 2022 episode results discussed in Chapter 5.

6.1.1 Total Anthropogenic Emissions Contributions to Design Values by Source Region

Figure 6-1 displays the total New Mexico (NM) and Permian Basin portion of New Mexico anthropogenic emissions contributions to the 2020-2024 ozone DVB and projected 2032 ozone DVF across the New Mexico 4 km modeling domain. The maximum New Mexico anthropogenic emissions contribution to the 2020-2024 ozone DVB is 12.7 ppb (Figure 6-1, top left) that occurs at the same location as the maximum 2020-2024 DVB (78.9 ppb; Figure 5-3, bottom left) near Carlsbad of which a vast majority (12.6 ppb or 99%) is due to emissions from the NM portion of the Permian Basin (Figure 6-1, bottom left). NM anthropogenic emissions also contribute elevated (> 7 ppb) ozone to the 2020-2024 DVB near Albuquerque and in the South San Juan Basin in northwest NM. The maximum contribution of NM anthropogenic emissions to the projected 2032 ozone DVF near Carlsbad is only reduced 0.2 ppb (12.5 ppb) and again is due to emissions from the Permian Basin portion of NM (12.5 ppb).

The maximum contribution of NM anthropogenic emissions outside of the Permian Basin (remainder NM) to the 2020-2024 DVB is 9.7 ppb and occurs near Albuquerque (Figure 6-2, top left). The maximum remainder NM anthropogenic emissions contribution to 2032 DVF is 8.2 ppb that occurs in northwest NM (Figure 6-2, top right). The maximum contribution of anthropogenic emissions from the Texas portion of the Permian Basin is 10.6 ppb that is reduced -26% to 7.8 ppb in 2032 (Figure 6-2, bottom panels)

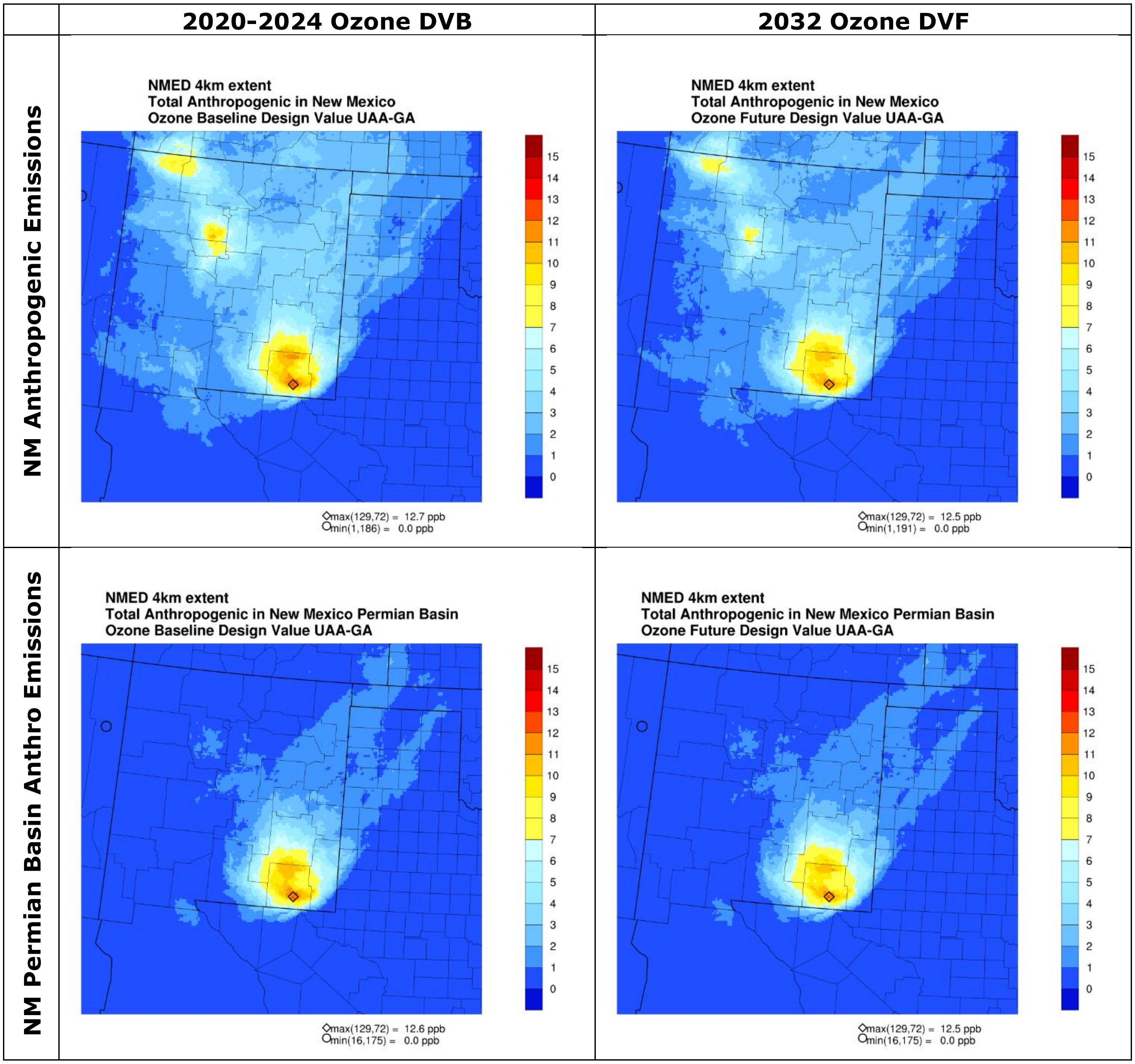

Figure 6-1. Contributions of total New Mexico anthropogenic emissions (top) and New Mexico Permian Basin anthropogenic emissions (bottom) to 2020-2024 ozone DVB (left) and New Mexico Permian Basin anthropogenic emissions (right).

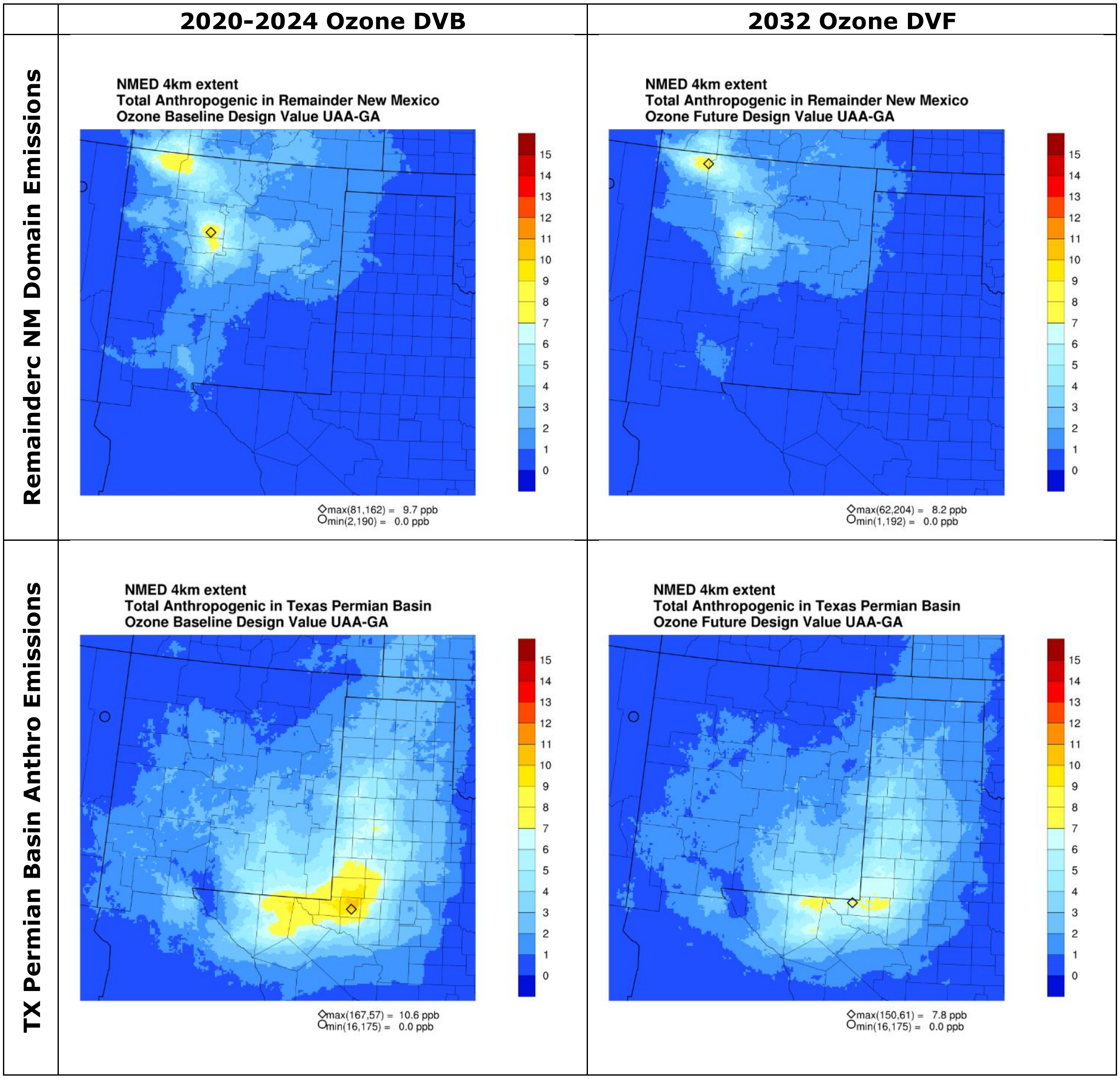

Figure 6-2. Contributions of remainder New Mexico domain anthropogenic emissions (top) and Texas Permian Basin anthropogenic emissions (bottom) to 2020-2024 ozone DVB (left) and New Mexico Permian Basin anthropogenic emissions (right).

6.1.2 Permian Basin Oil and Gas Contributions to Ozone Design Values

In this section we examine the contributions of O&G emissions in the Permin Basin to the base year DVB and 2032 DVF by location (NMPB, TXPB and total PB) and the three O&G Source Categories: Pre-Production (OGD), Production (OGP) and Midstream (OGM). Figure 6-3 displays the NMPB Source Region O&G emissions contributions to the 2020-2024 ozone DVB by Source Category. The total NMPB O&G maximum contribution is 12.4 ppb near Carlsbad in southern Eddy County, which is 98% of the total NM Anthropogenic emissions contribution (12.7 ppb; Figure 6-1, top left). The maximum contribution of NMPB O&G to the 2020-2024 DVB by Source Category is 5.1 ppb (OGD), 3.9 ppb (OGP) and 5.7 ppb (OGM) with the NMPB Pre-Production and Production maximums occurring at the same location in southern Eddy County where the peak NMPB total O&G occurs while the NMPB O&G Midstream maximum occurs in northern Eddy County.

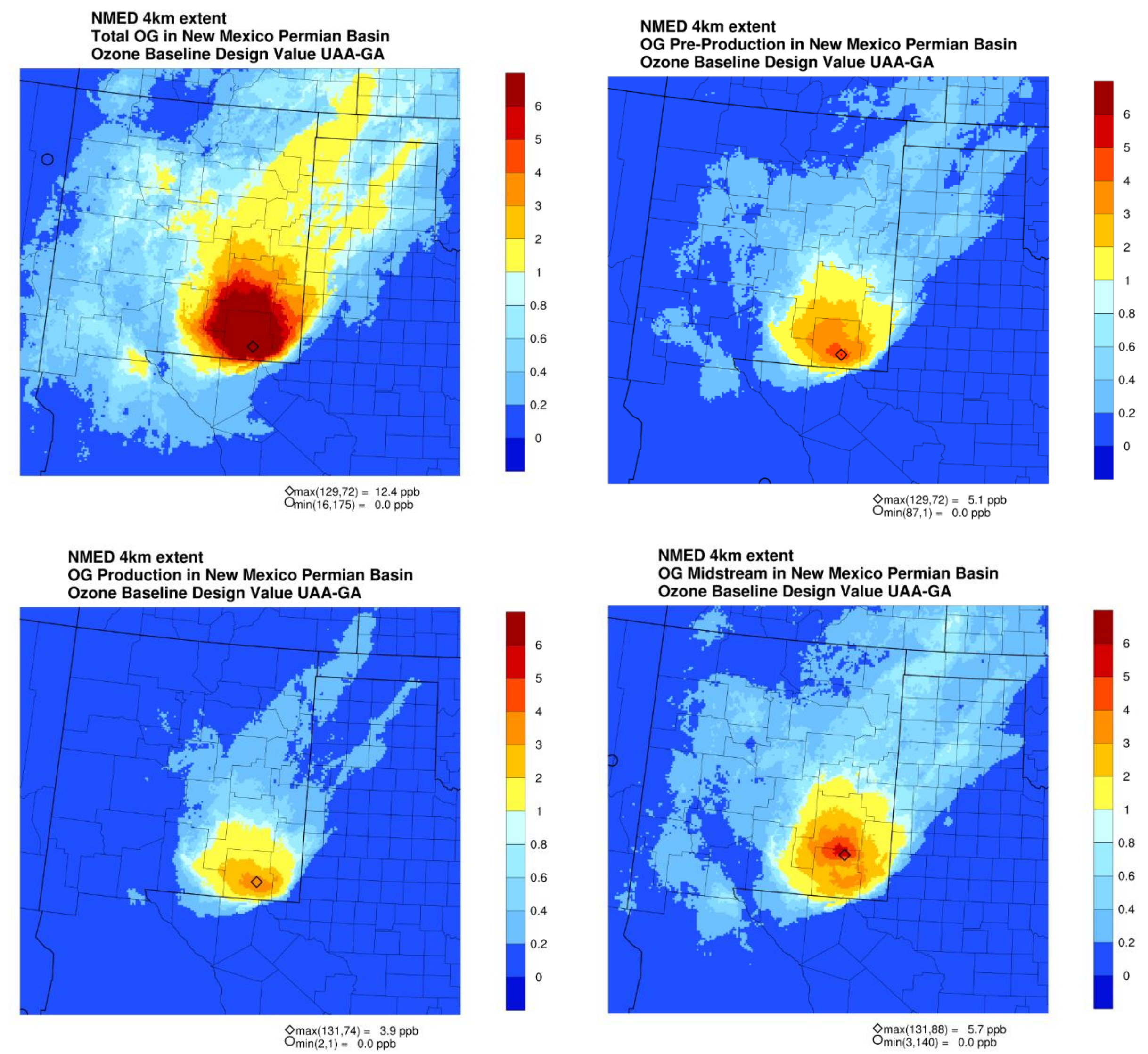

Figure 6-3. Contributions of New Mexico Permian Basin Oil and Gas emissions to 2020-2024 ozone DVB for all O&G (top left), Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

Figure 6-4 is similar to Figure 6-3 only showing NMPB O&G contributions to the projected 2032 ozone DVF. The contributions of NMPB O&G to 2032 DVF for total, O&G and Pre-Production is similar to their contributions to the 2020-2024 DVB (12.3 vs. 12.4 ppb and 5.2 vs. 5.1 ppb). But the contributions of NMPB O&G to 2032 DVF for Production (3.3 ppb) is slightly lower than for 2020-2024 DVB (3.9 ppb) and Midstream 2032 DVF contribution (6.3 ppb) is slightly higher than the contribution to 2020-2024 DVB (5.7 ppb).

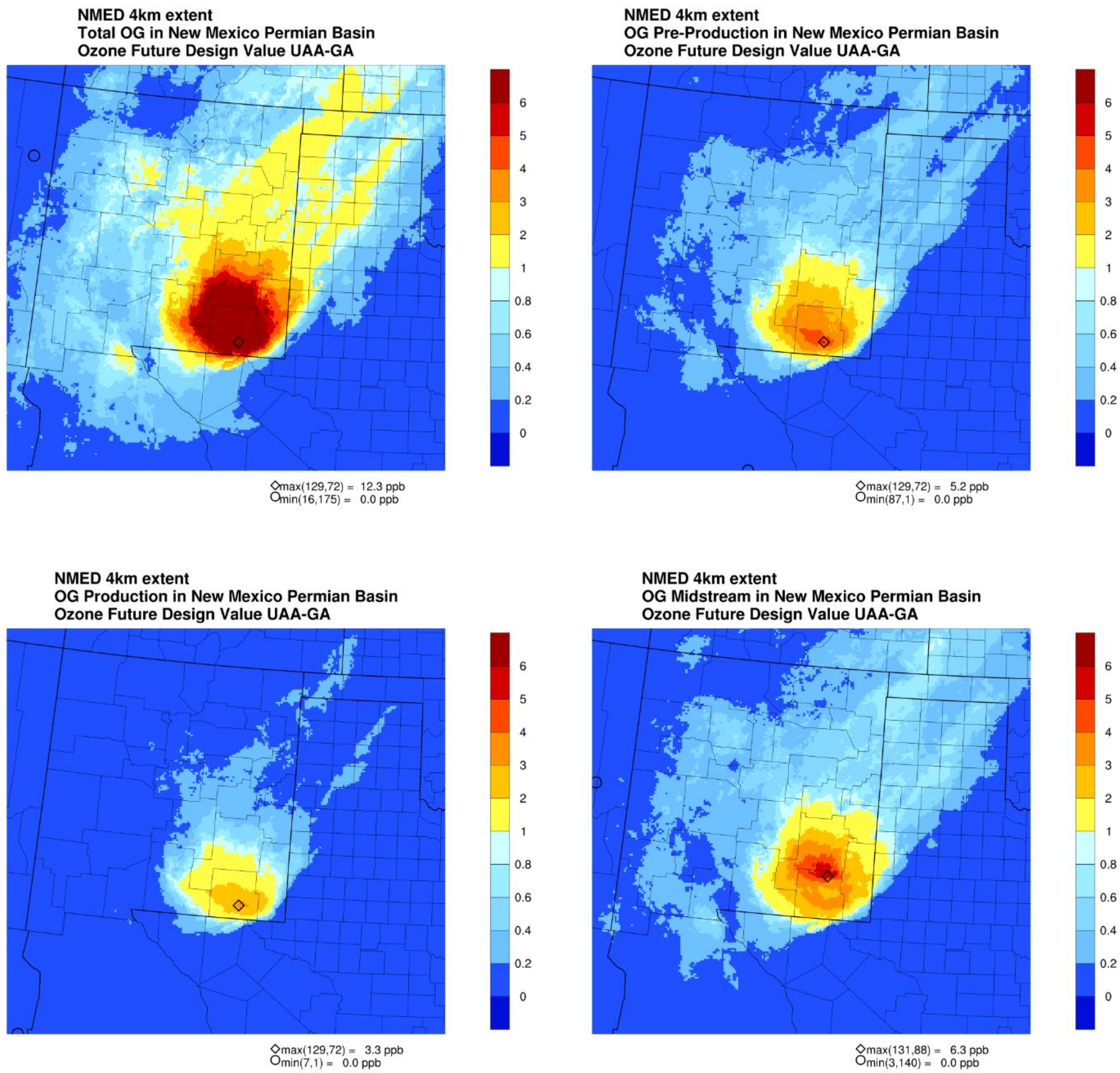

Figure 6-4. Contributions of New Mexico Permian Basin Oil and Gas emissions to projected 2032 ozone DVF for all O&G (top left), Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

Figures 6-5 and 6-6 display the contributions of TXPB O&G to the, respectively, 2002-2024 ozone DVB and projected 2032 ozone DVF. Whereas the maximum NMPB O&G contribution saw little change to the 2020-2024 DVB and 2032 DVF (12.4 ppb vs. 12.3 ppb), larger reductions (-14%) are seen in the maximum TXPB O&G contributions between 2020-2024 DVB (7.7 ppb) and 2032 DVF (6.6 ppb). The TXPB O&G ozone contributions greater than 4 ppb impact southern Eddy and southern and eastern Lea Counties in New Mexico including the Hobbs and Carlsbad monitoring sites. The distribution of ozone contributions across the TXPB O&G Source Categories is quite different from the NMPB with a vast majority of the ozone contribution coming from the TXPB O&G Midstream category (e.g., ~80% of the peak TXPB O&G ozone concentrations to the DVB and DVF). As noted previously, future year O&G projections are lower in the TX than NM portions of the Permian Basin.

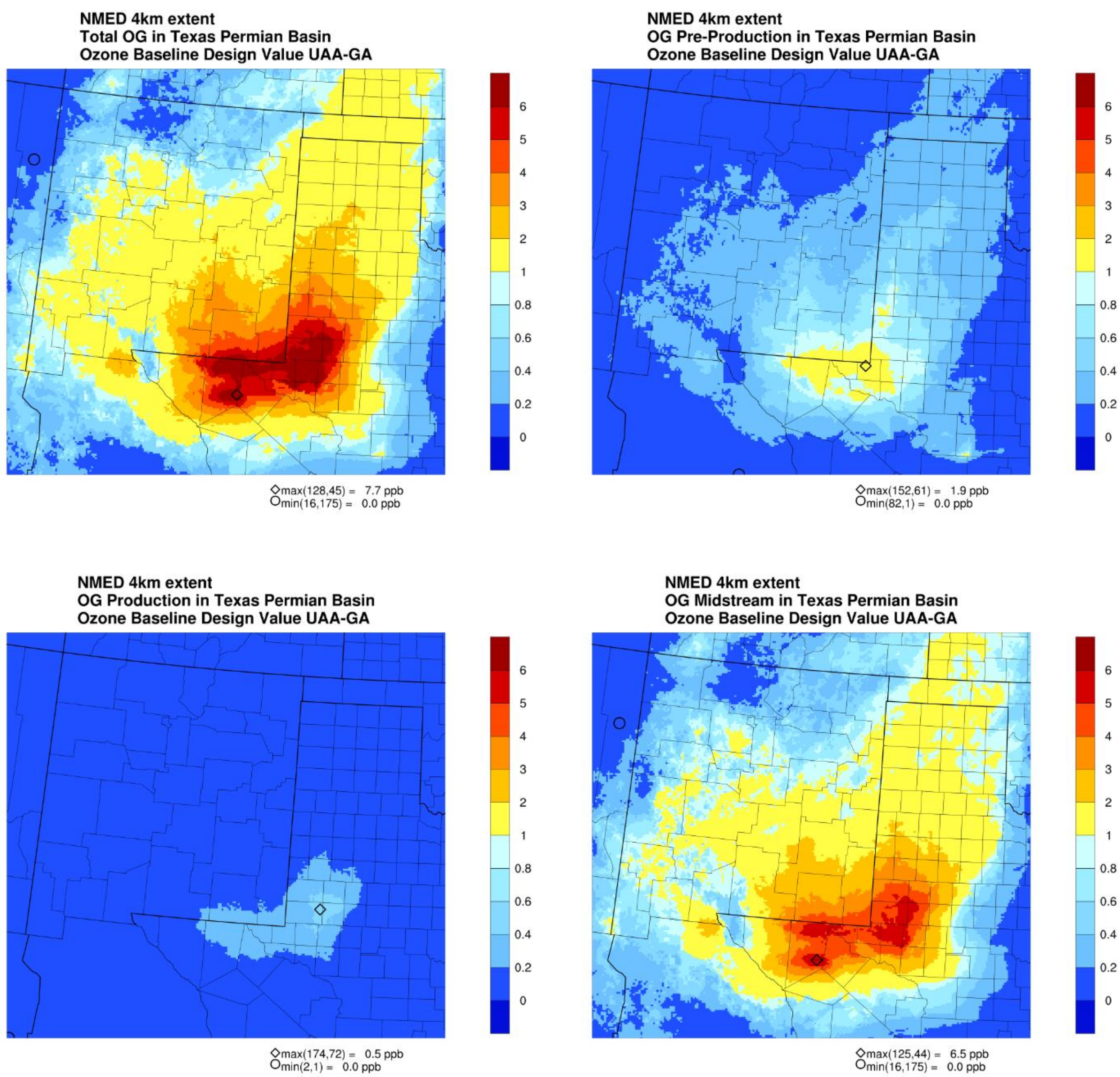

Figure 6-5. Contributions of Texas Permian Basin Oil and Gas emissions to 2020-2024 ozone DVB for all O&G (top left) Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

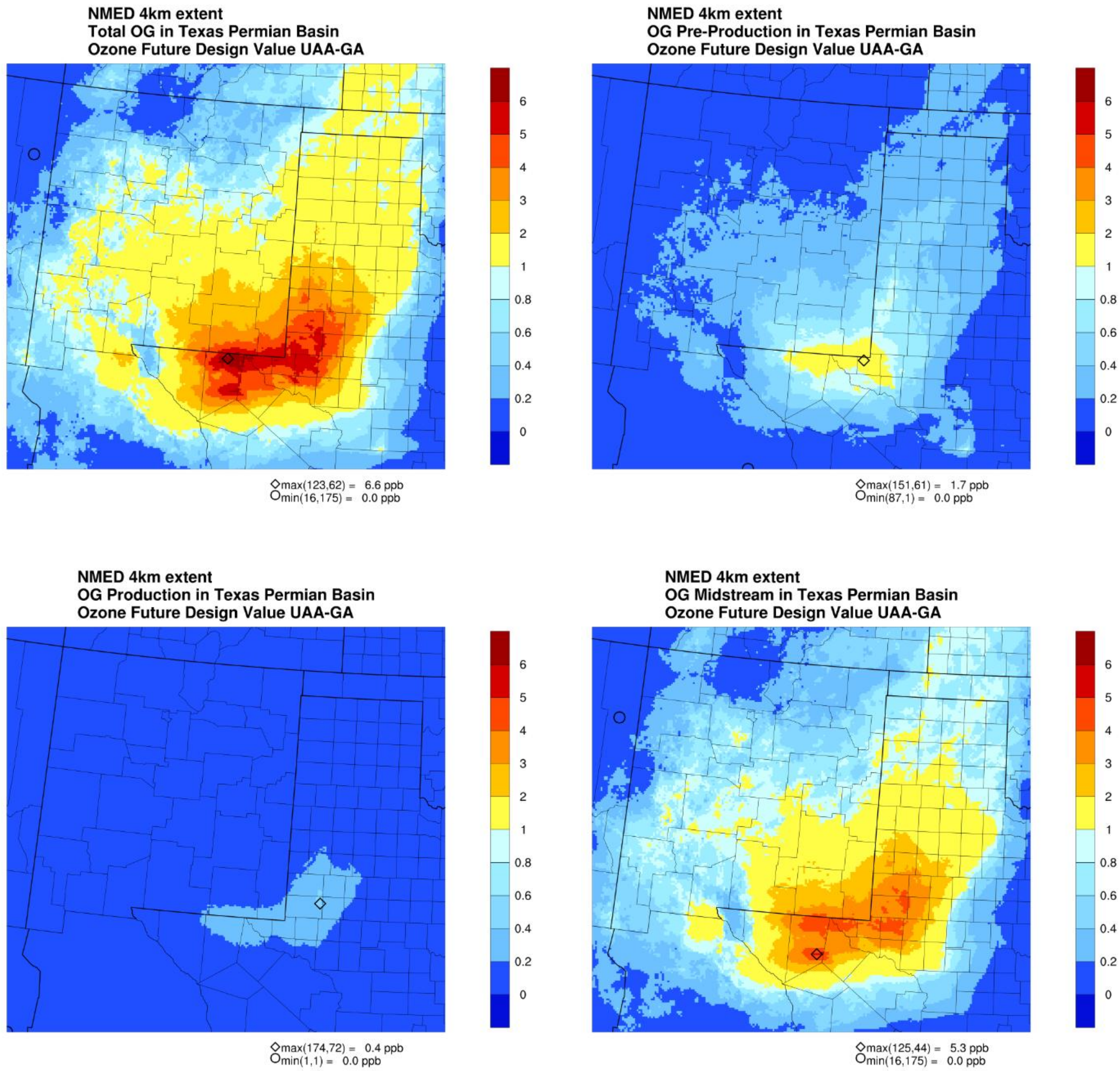

Figure 6-6. Contributions of Texas Permian Basin Oil and Gas emissions to projected 2032 ozone DVF for all O&G (top left) Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

Figures 6-7 and 6-8 displays the total (NM+TX) Permian Basin O&G contributions to the, respectively, 2020-2024 ozone DVB and projected 2032 ozone DVF. Results are similar as discussed above.

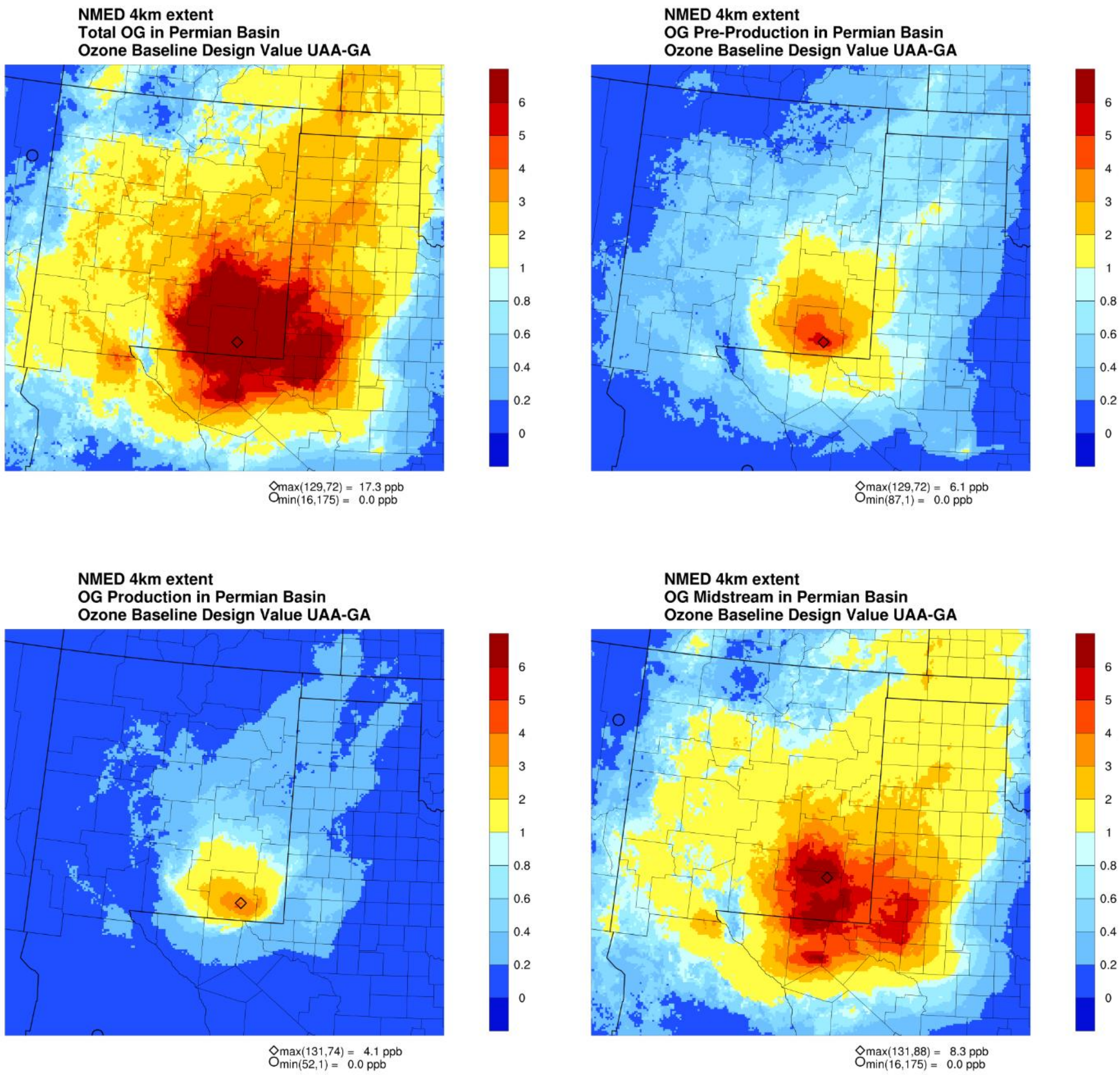

Figure 6-7. Contributions of New Mexico and Texas Permian Basin Oil and Gas emissions to 2020-2024 ozone DVB for all O&G (top left) Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

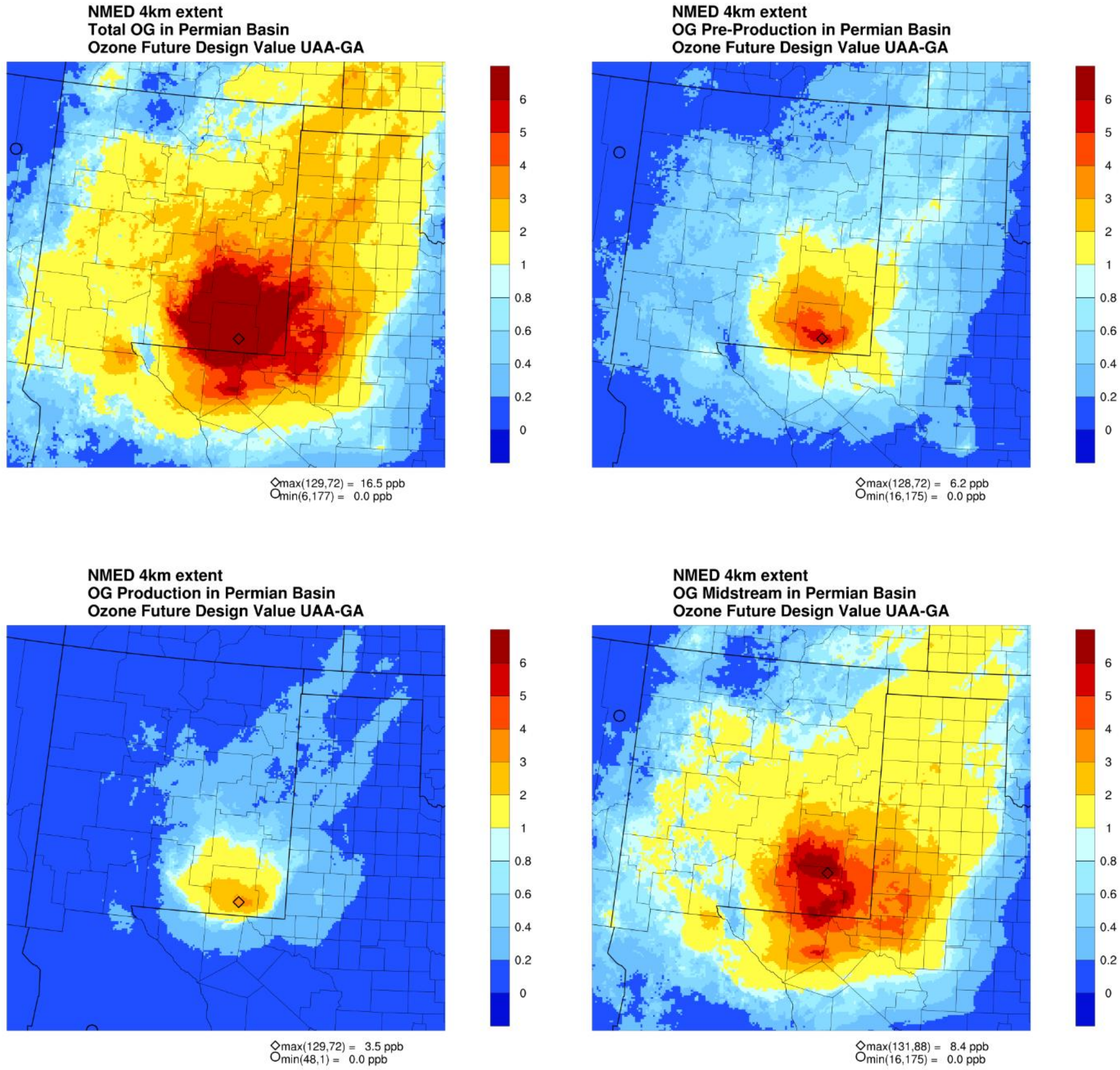

Figure 6-8. Contributions of New Mexico and Texas Permian Basin Oil and Gas emissions to projected 2032 ozone DVF for all O&G (top left) Pre-Production O&G (top right), Production O&G (bottom left) and Midstream O&G (bottom right).

6.1.3 Anthropogenic Source Sector Contributions to Ozone Design Values across the New Mexico 4 km Domain

The spatial distributions of the contributions of the major Source Sectors from the NM and TX Permian Basin, Remainder NM and Remainder 12/4 km domain Source Regions to the 2020-2024 DVB and projected 2032 DVF are shown in, respectively, Figure 6-9 and Figure 6-10 with maximum contributions anywhere in the New Mexico 4 km domain given in Table 6-1. The contributions of the O&G Source Sector to the 2020-2024 DVB and 2032 DVF were shown previously. Of the local New Mexico 4 km domain Source Regions (NMPB, TXPB, remainder NM), NMPB O&G emissions (~12.5 ppb) have the highest contributions to the base and future year ozone Design Values followed by TXPB O&G (7.7 and 6.6 ppb). On-Road mobile has the largest ozone reductions from 2022 to 2032 followed by EGU Point.

Table 6-1. Maximum contributions to the 2020-2024 ozone DVB and projected 2032 ozone DVF (ppb) by Source Sector emissions from the New Mexico Permian Basin, Remainder New Mexico and Texas Permian Basin regions.

Source	NM Permian Basin		Remainder NM		TX Permian Basin	
Sector Sector	2020-4 DVB	2032 DVF	2020-4 DVB	2032 DVF	2020-4 DVB	2032 DVF
Oil & Gas	12.4	12.3	7.5	7.4	7.7	6.6
On-Road	0.8	0.2	4.8	2.4	2.4	0.9
Non-Road	0.3	0.2	2.4	2.4	1.1	0.8
EGU Point	0.8	0.4	2.2	1.5	2.9	2.3
Non-EGU Pt	0.2	0.2	0.7	0.7	0.5	0.3
Non-Point	0.2	0.1	1.6	1.7	0.4	0.4

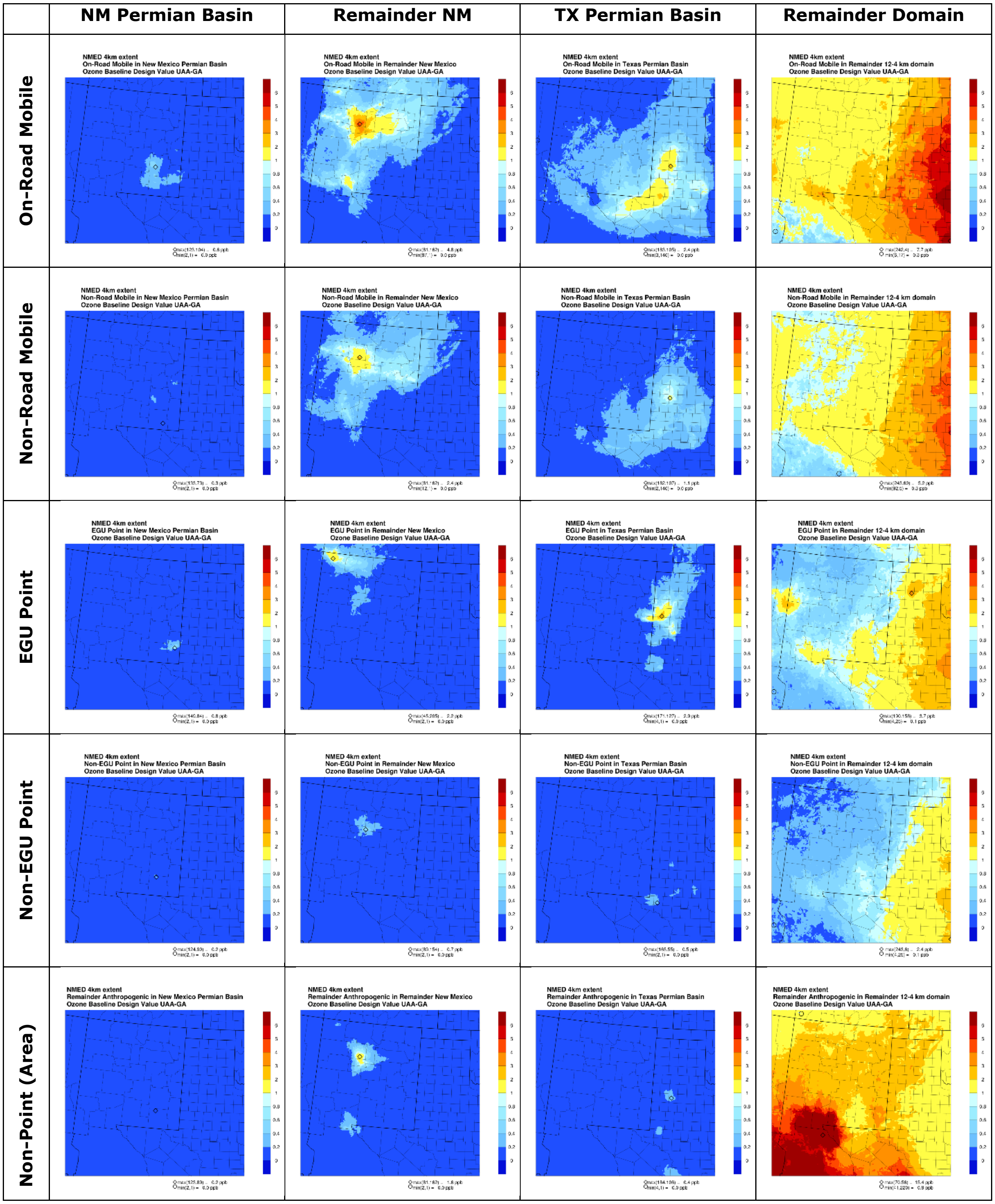

Figure 6-9. Contributions of anthropogenic Source Categories (except O&G) to 2020-2024 ozone DVB from four Source Regions (left to right) and five Source Categories (from top to bottom): New Mexico Permian Basin, Remainder New Mexico, Texas Permian Basin, and Remainder Domain) and Source Categories (top to bottom).

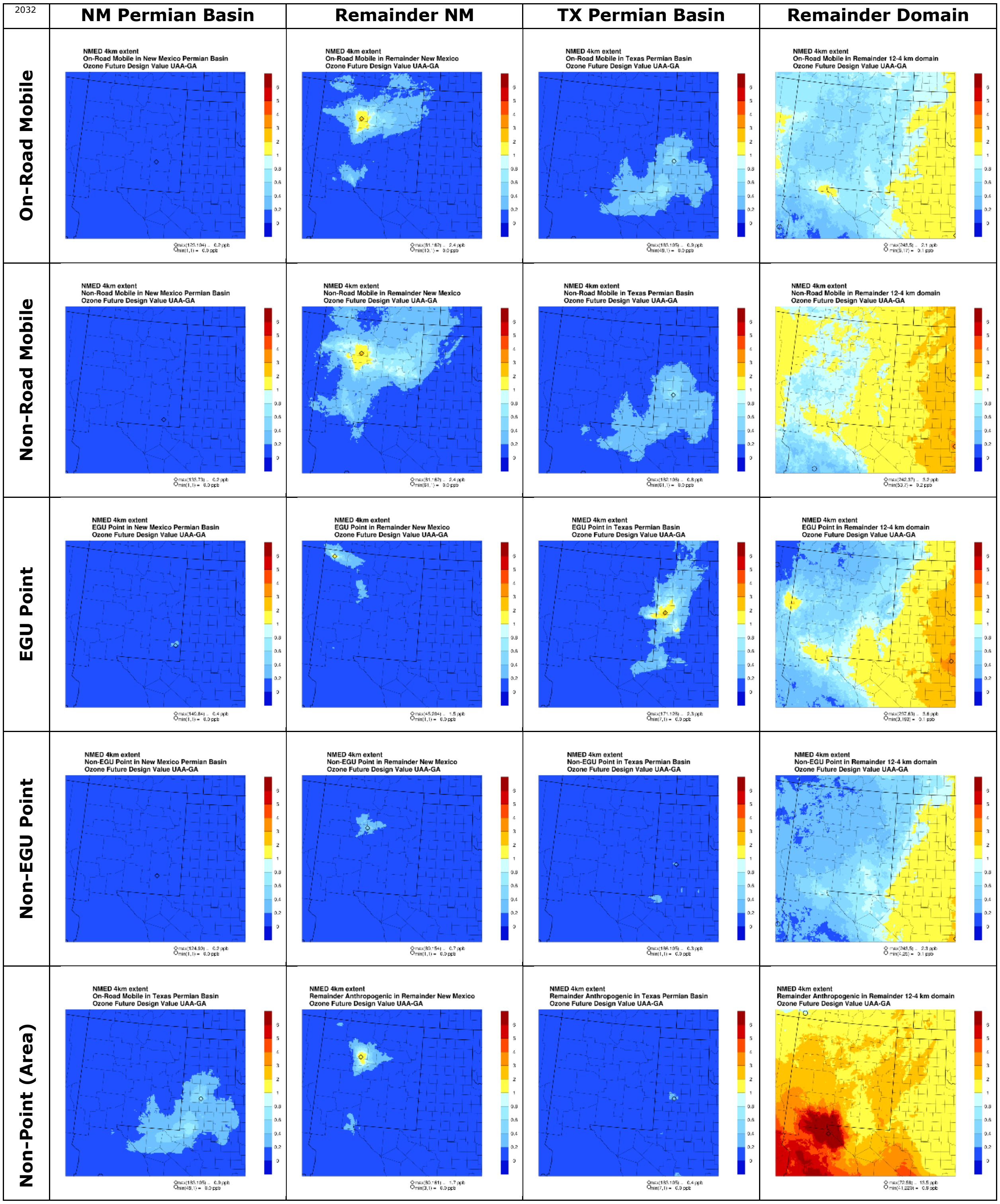

Figure 6-10. Contributions of anthropogenic Source Categories (except O&G) to projected 2032 ozone DVF from four Source Regions (left to right) and five Source Categories (from top to bottom): New Mexico Permian Basin, Remainder New Mexico, Texas Permian Basin, and Remainder Domain) and Source Categories (top to bottom).

6.2 Local Source Ozone Contributions at Monitoring Sites

The CAMx 2022 and 2032 Local Source ozone source apportionment MDA8 ozone modeling results were extracted at the monitoring sites in the New Mexico 4 km domain and loaded into Excel Dashboards that display pie charts and stacked bar charts of MDA8 ozone contributions for user-selected monitors, Source Groups, and days. Standard Excel Dashboards were developed for the 2022 and 2032 Local Source MDA8 ozone concentrations for all monitoring sites in the New Mexico 4 km domain as well as additional Dashboards for the three New Mexico Permian Basin sites that display 2022 and 2032 MDA8 ozone contributions with the Permian Basin O&G ozone contributions adjusted upward to account for the missing O&G emissions and ozone underestimation bias. These upward adjustments in the two Permian Basin O&G ozone contributions were made using the same approach as used to adjust Permian Basin O&G contributions to the 2020-2024 ozone DVB to make future year 2032 ozone DVF projections using the alternative DVF projection approach based on Local Permian Basin and Non-Local Permian Basin ozone DVB increments as described in Section 5.2.

6.2.1 User Control of 2022 and 2032 MDA8 Ozone Contribution Dashboards

Figure 6-11 displays a screen shot of the Local Source 2022 MDA8 Ozone Contribution Dashboard. The user selects a monitoring site in the New Mexico 4 km domain in the "Site ID" selection box in the top left corner of the Dashboard (Carlsbad City in this case) and the user can select the Source Regions and Source Categories under the "Region" and "Category" selection boxes on the left side of the Dashboard with the following definitions:

Source Regions

A. **BCD**: Boundary Conditions
B. **NMPB**: New Mexico portion of the Permian Basin
C. **NMRE**: Remainder New Mexico
D. **REMD**: Remainder 12/4 km Domains
E. **TXPB**: Texas portion of the Permian Basin

Source Categories

1. **BCD**: Boundary Conditions
2. **EGU**: Eletrical Generating Units
3. **FIR**: Fires
4. **NAT**: Natural (Biogenic + LNOx)
5. **NEG**: Non-EGU Point
6. **NON**: Nonroad Mobile
7. **OGD**: Pre-Production O&G
8. **OGM**: Midstream O&G
9. **OGP**: Production O&G
10. **ONR**: On-Road Mobile
11. **REA**: Remainder Anthropogenic

In the example in Figure 6-11, all Source Regions and all Source Categories are selected. The top selection boxes control the days for displaying the MDA8 ozone contribution pie and bar charts with the selection boxes on the top left having options for selecting the top 10 MDA8 days, the 10 days used by SMAT-CE to make future year ozone DVF projections, days over 60, 65, or 70 ppb, or all days. The user can further refine the days selected using the "Month" and "Date of Month" selection boxes. In the example in Figure 6-11, the 10 SMAT MDA8 ozone days are selected and since they are the modeling results used to make the DVF projections following EPA guidance (EPA, 2018a) their contributions can be viewed as the contributions to the projected ozone Design Values.

After the user selects the monitoring site, Source Regions and Categories, and days, the 2022 MDA8 Ozone Dashboard displays the average ozone contributions across the days in a pie chart with a legend above the pie chart listing the monitoring site name, average 2022 MDA8 concentration across the selected days, and the observed 2020-2024 ozone DVB. Also displayed are stacked bar charts of MDA8 ozone contributions for each of the selected the days showing the contributions of selected Source Categories and Boundary Conditions (BCs). For the average of the 10 SMAT 2022 MDA8 ozone days at Carlsbad City (63.77 ppb), BCs (BCD) contribute a little over half (54%) with natural sources contributing 9% and the remaining 47% coming from anthropogenic emissions in the 12/4 km domains.

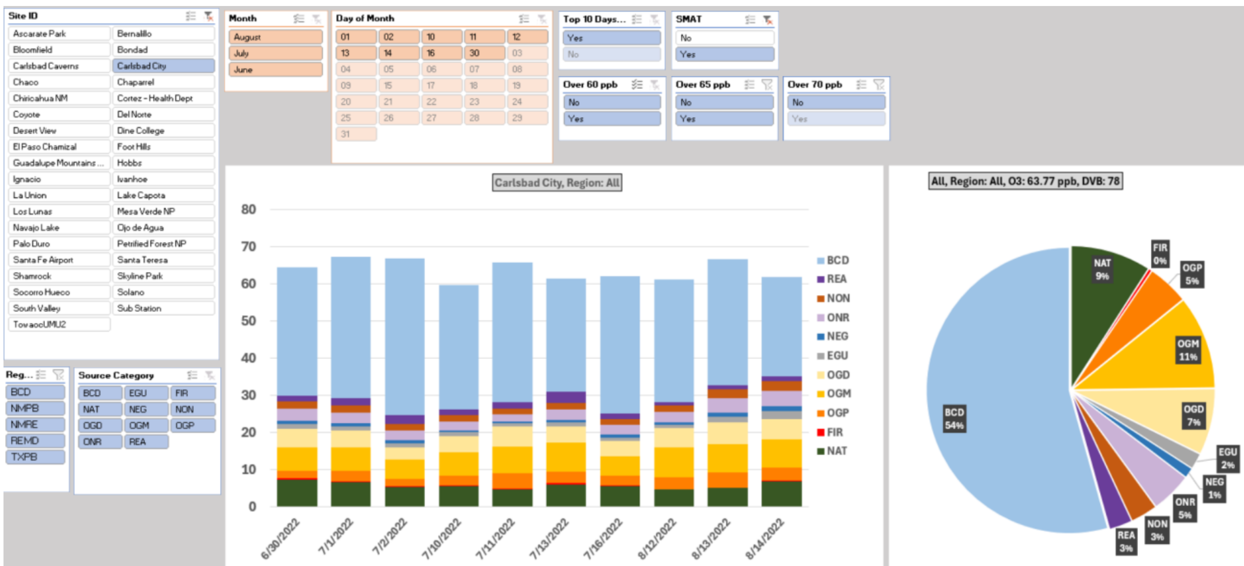

Figure 6-11. 2022 MDA8 ozone Dashboard screen shot showing selections for monitoring site (Carlsbad City), Source Regions (All) and Categories (All) and days to display bar and pie charts (10 SMAT days).

6.2.2 2022 and 2032 Local Source Ozone Contributions at New Mexico Permian Basin Ozone Monitoring Sites

Figure 6-12 displays the 2022 and 2032 MDA8 Dashboards for Carlsbad City and all Source Regions and Source Groups (the 2022 Dashboard is same as in Figure 6-11). The 2032 MDA8 ozone concentrations tend to be slightly lower than 2022 with an average across the 10 SMAT days of 60.8 ppb compared to 63.8 ppb in 2022. This results in the percent BC contribution in 2032 (58%) being slightly higher than 2022 (54%) even though the magnitude of the BC contribution is nearly identical (34.6 ppb in 2022 versus 34.9 ppb in 2032) as the 12 km domain BCs remain unchanged between the CAMx 2022 and 2032 simulations.

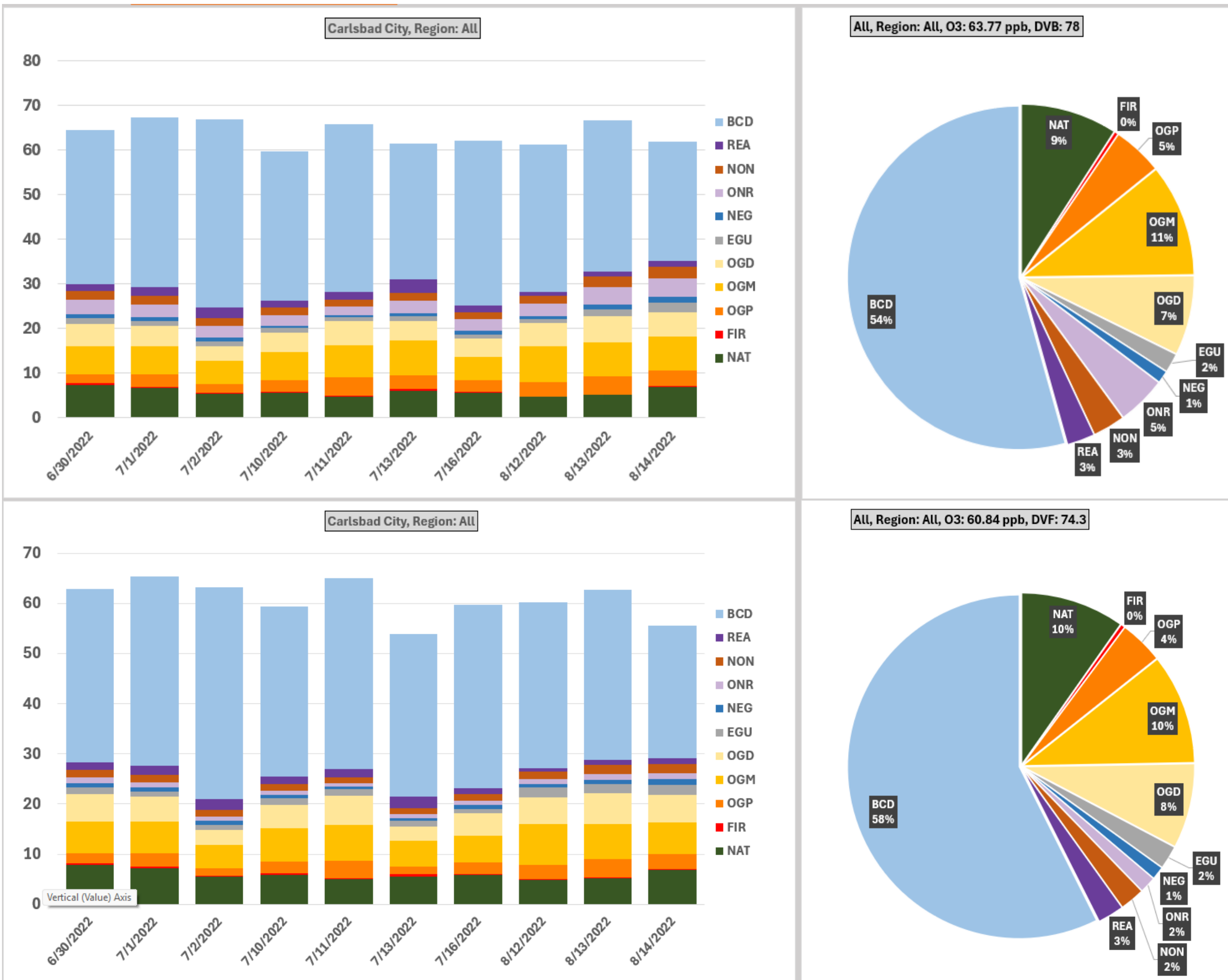

Figure 6-12. Carlsbad City 2022 (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

Figure 6-13 displays pie charts of Source Category contributions to the 2022 MDA8 ozone concentration at Carlsbad City site averaged across the 10 SMAT days for the four Source Regions used in the CAMx 2022v2 12/4 km Local Source ozone source apportionment simulation. The NMPB Source Region contributes 9.8 ppb (15%) with a vast majority (94%) coming from O&G sources with O&G Pre-Production (37%) contributing more than O&G Production and Midstream (28-29% each). The TXPB Source Region contributes 5.5 ppb (9%) with O&G contributing 64% of the TXPB Source Region contribution to the 2022 MDA8 ozone at Carlsbad City averaged across the 10 SMAT days. The remainder New Mexico domain Source Region has a very small contribution (0.2 ppb) at Carlsbad City. The remainder of the 12/4 km domain (i.e., not New Mexico or TXPB) contributes 13.7 ppb (21%) with a third of that coming from natural sources and the major source categories of O&G, point, on-road, non-road and area contributing 13-16% each.

The Source Region contributions for 2032 at Carlsbad City site (not shown) are very similar to 2022 with a 2.9 ppb reduction in MDA8 ozone averaged across the 10 SMAT days (63.77 vs. 60.84 ppb). Of this 2.9 ppb reduction, 2.0 ppb reduction is coming from on-road mobile sources, 0.5 ppb is from non-road mobile sources, and 0.9 ppb from O&G sources with small increases from other Source Categories even ones that don't change between 2022 and 2032 (e.g., +0.3 ppb for BCs and +0.1 ppb for Natural) likely due to lower mobile NO_X emissions increasing the ozone formation efficiency due to other NO_X emissions. The 2022 vs. 2032 Source Region's MDA8 ozone contributions averaged across the 10 SMAT days are as follows: NMPB 9.8 vs. 9.4 ppb; Remainder NM 0.21 vs. 0.20 ppb; TXPB 5.5 vs. 4.4 ppb; Remainder 12/4 km domain 13.7 vs. 11.9 ppb.

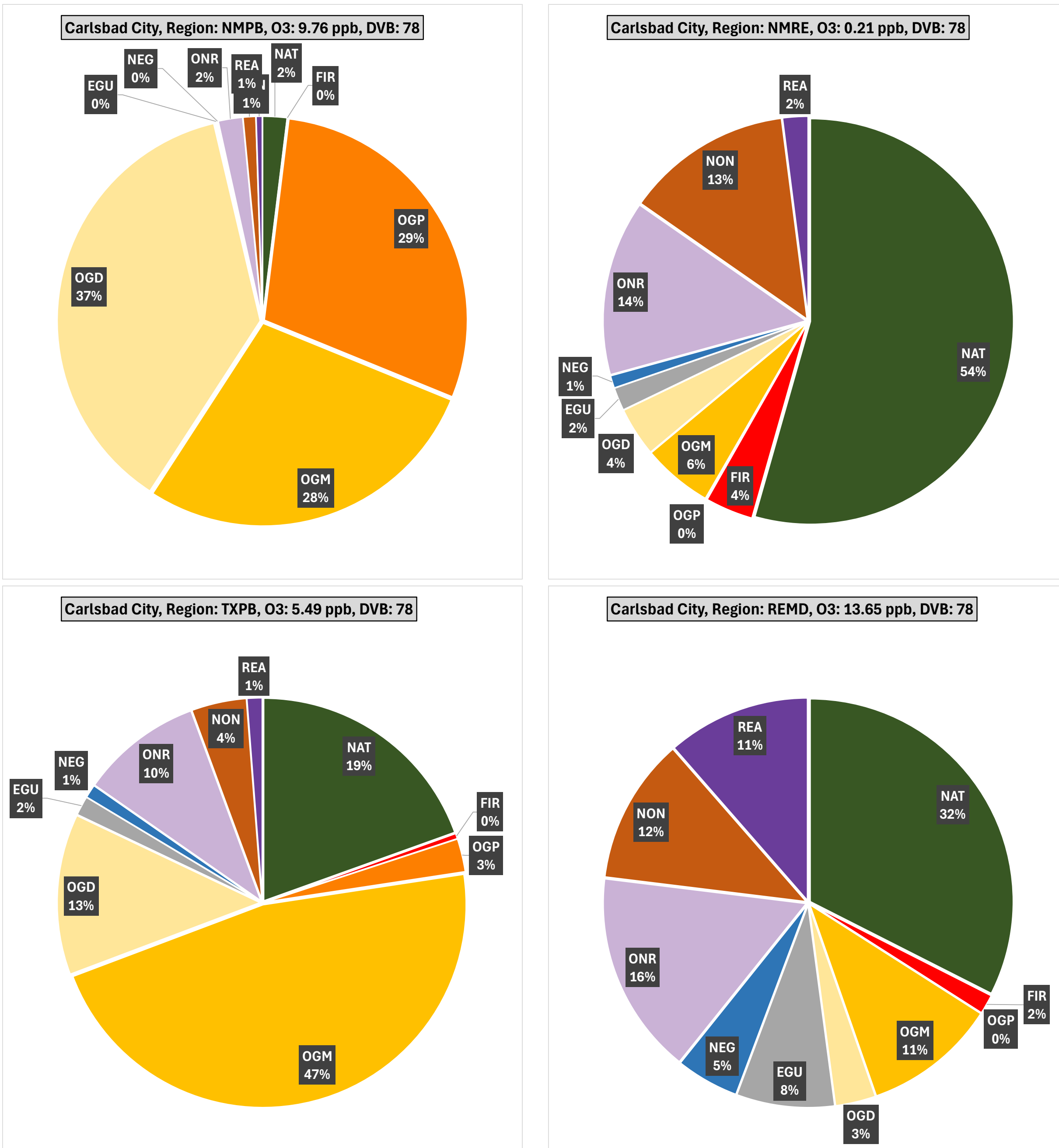

Figure 6-13. Carlsbad City contributions of Source Categories in the NMPB (top left), remainder NM (top right), TXPB (bottom left) and remainder 12/4 domain (bottom right) to the 2022 MDA8 ozone concentrations average across the 10 SMAT days.

Figure 6-14 displays the 2022 Source Category MDA8 ozone contributions by Source Region for all days in the June – August 2022 Local Source episode. There is a lot of day-to-day variability in the Source Region contributions to 2022 MDA8 ozone concentrations at Carlsbad City that depend in part on wind direction. Not surprisingly, the NMPB Source Region ozone contribution is dominated by the O&G Source Categories (Figure 6-14, top left). The Remainder NM domain ozone contributions (Figure 6-14, top right) tend to have a relatively higher Natural contribution (green) and early in the modeling period has a fire ozone contribution (red) due to the Calf Canyon/Hermits Peak and Black wildfires that are the two largest wildfires in modern New Mexico history and were particularly active in May and June. The O&G Source Category has the highest daily ozone contributions to 2022 MDA8 ozone at Carlsbad City from the TXPB Source Region followed by natural and on-road mobile (Figure 6-14, bottom left). Finaly, the remainder of the 12/4 km domain has contributions from just about all Source Categories with natural and on-road and non-road mobile being the highest contributors.

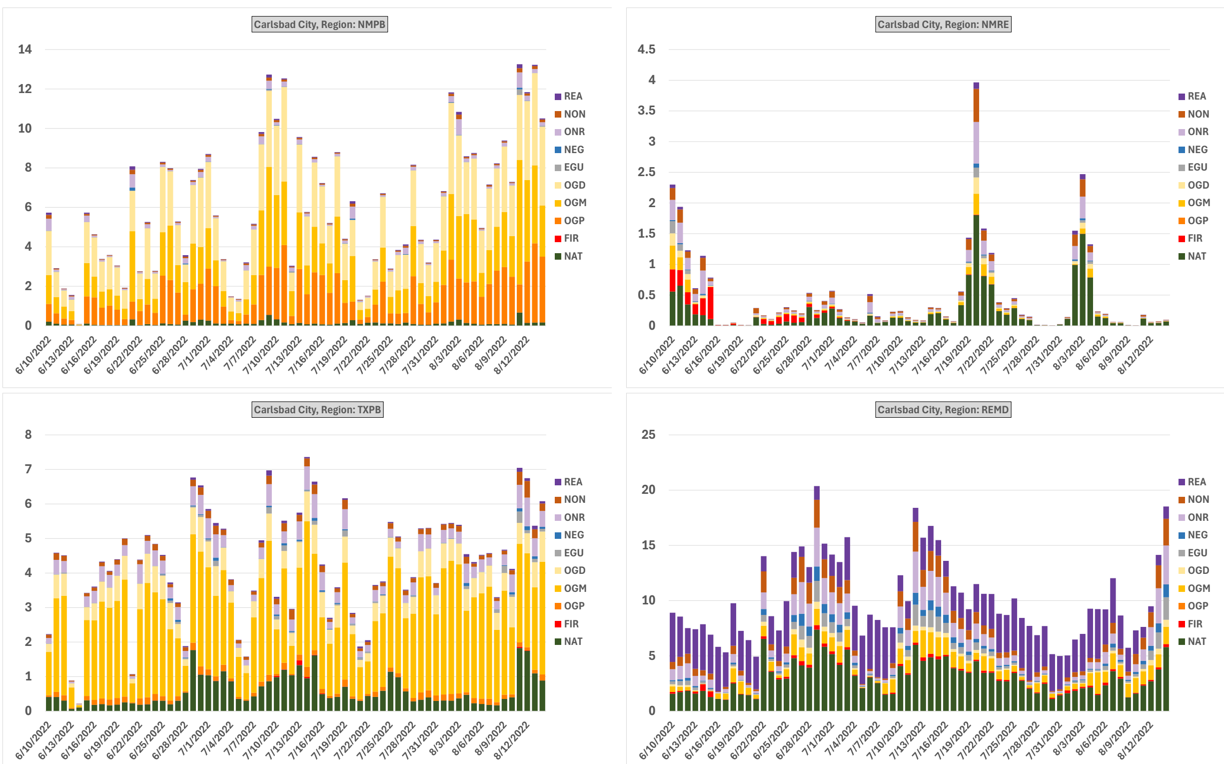

Figure 6-14. Carlsbad City ozone contributions to 2022 MDA8 ozone concentrations from the NMPB (top left), NMRE (top right), TXPB (bottom left) and REMD Source Regions, all Source Categories, and all days of the June 10 – August 15, 2022 modeling episode.

The ozone contributions at Carlsbad Caverns look very similar to Carlsbad City, only they are a little bit lower since Carlsbad Caverns is further away from the more intense O&G development areas in the Permian Basin than Carlsbad City.

Figure 6-15 displays the 2022 and 2032 MDA8 ozone concentrations on the 10 SMAT days at Hobbs monitor in Lea County with Figure 6-16 showing the contributions by Source Region. Hobbs has a higher relative BC contribution in 2022 (61%) and 2032 (65%) than Carlsbad City. Hobbs has a lower ozone contribution than Carlsbad City from the NMPB Source Region (3.7 vs. 9.8 ppb) but the same ozone contribution from the TXPB Source Region (~5.5 ppb).

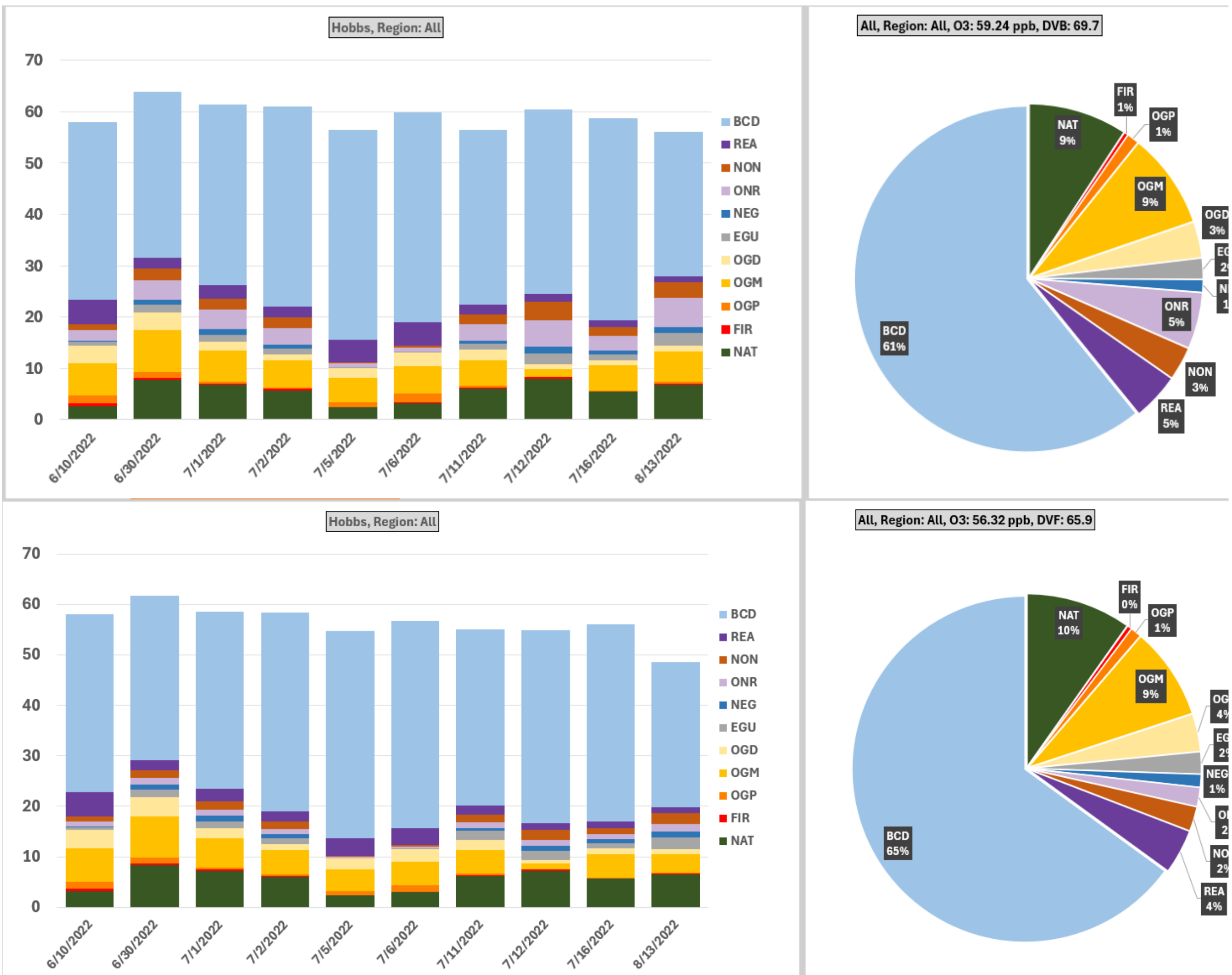

Figure 6-15. Hobbs 2022 (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

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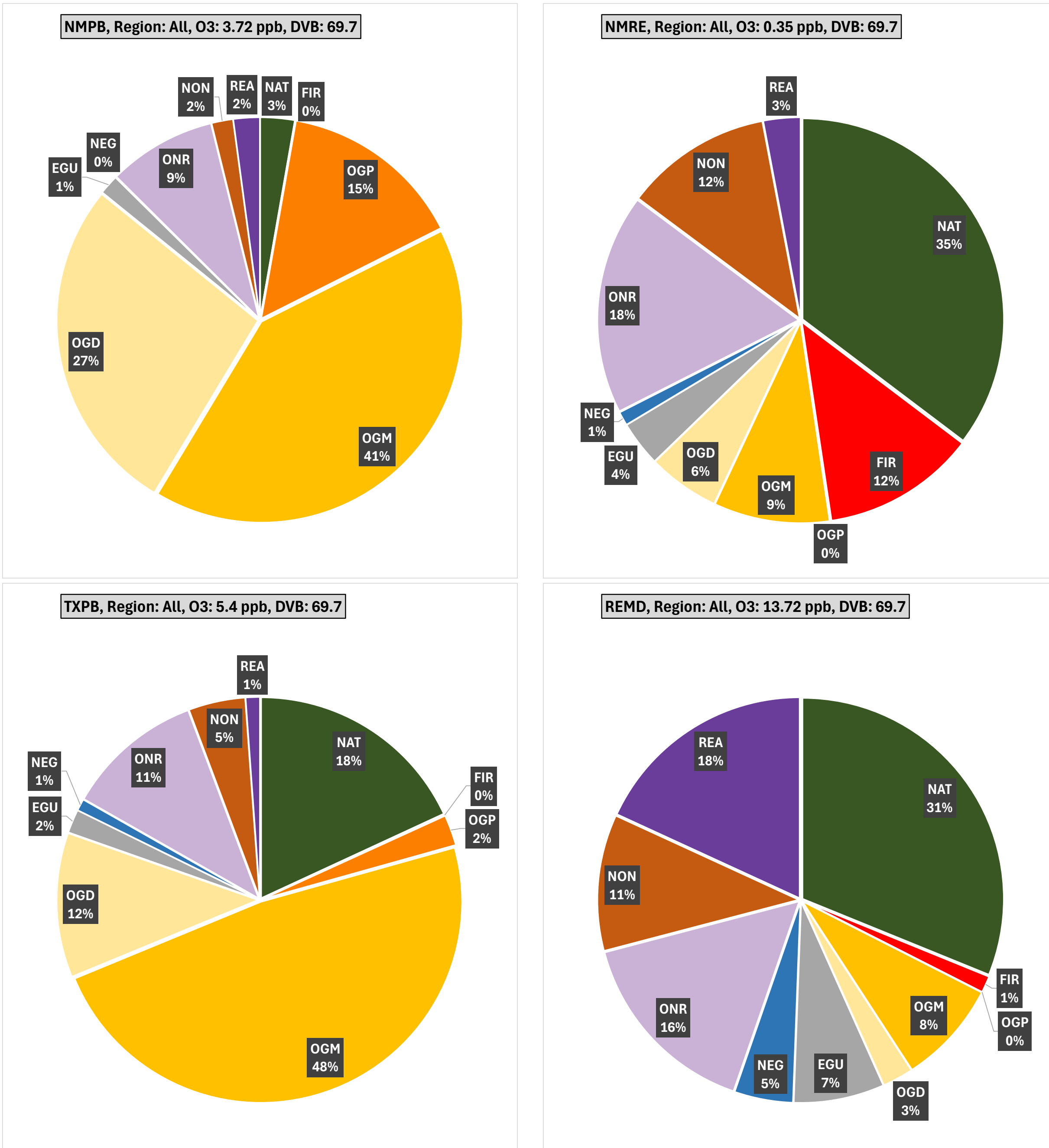

Figure 6-16. Hobbs contributions of Source Categories in the NMPB (top left), remainder NM (top right), TXPB (bottom left) and remainder 12/4 domain (bottom right) to the 2022 MDA8 ozone concentrations average across the 10 SMAT days.

Figure 6-17 displays the Source Category contributions to 2022 MDA8 ozone concentrations at Hobbs for all days in the June 10 – August 15 modeling episode. The Source Category contributions range from 8 to 33 ppb. On average, O&G contributes the most (34%) with Midstream (24%) being the largest O&G subcategory (as noted previously, Midstream O&G dominates the TXPB O&G ozone contribution). Natural (22%) is the next largest contributing Source Category followed by remainder anthropogenic (17%), on-road mobile (12%) and non-road mobile (7%).

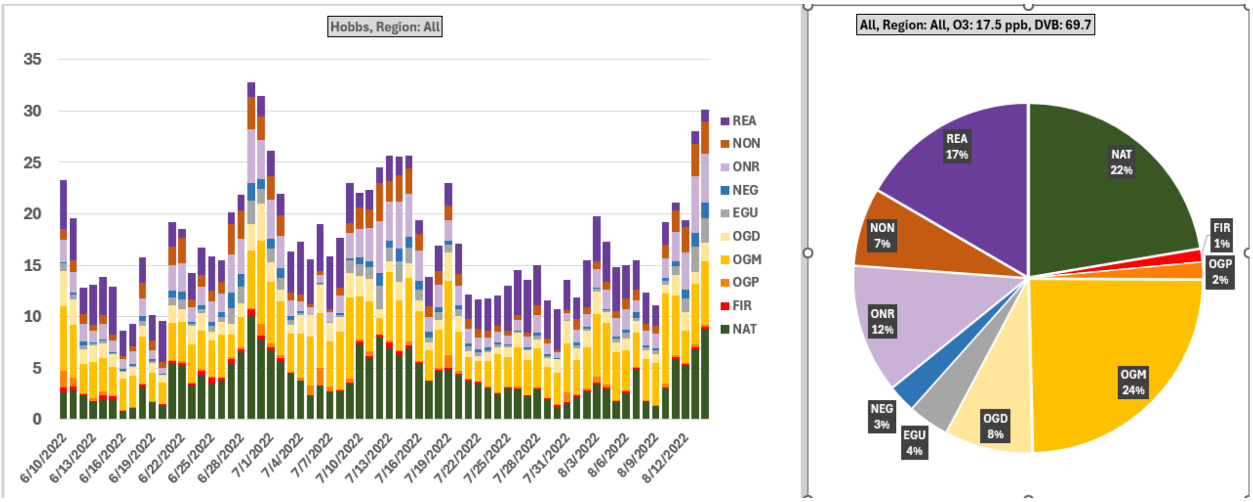

Figure 6-17. Source Category contributions to 2022 MDA8 ozone concentrations from all Source Regions and all days at the Hobbs monitoring site.

6.2.3 2022 and 2032 Local Source Ozone Contributions at Southern New Mexico Ozone Monitoring Sites

The Desert View monitoring site in Doña Ana County is used to illustrate the Local Source ozone contributions for the southern New Mexico and El Paso monitoring sites since it has the highest base year ozone DVB (77.3 ppb) and projected 2032 ozone DVF (72.7 ppb).

Figure 6-18 show the contributions of Source Categories to the 2022 and 2032 MDA8 ozone at Desert View for the 10 SMAT days. BCs contribute 58% (2022) and 62% (2032) to the average of the MDA8 ozone concentrations for the 10 SMAT days at Desert View. The largest Source Category contribution is remainder anthropogenic, which is likely mainly from Mexico as it also includes mobile sources in the Mexican emissions inventory. There is a 3.9 ppb reduction in the average MDA8 ozone between 2022 (62.8 ppb) and 2032 (59.9 ppb) that is mainly due to reductions in U.S. on-road mobile reductions (1.8 ppb).

Figure 6-19 displays the Source Category contributions to 2022 MDA8 ozone concentrations at Desert View for all days in the modeling episode. Remainder anthropogenic (42%) has the largest contributions followed by natural (22%), both of which are largely uncontrollable by U.S. regulations as a majority of the remainder anthropogenic are low-level emissions from Mexico (e.g., on-road, non-road and area sources).

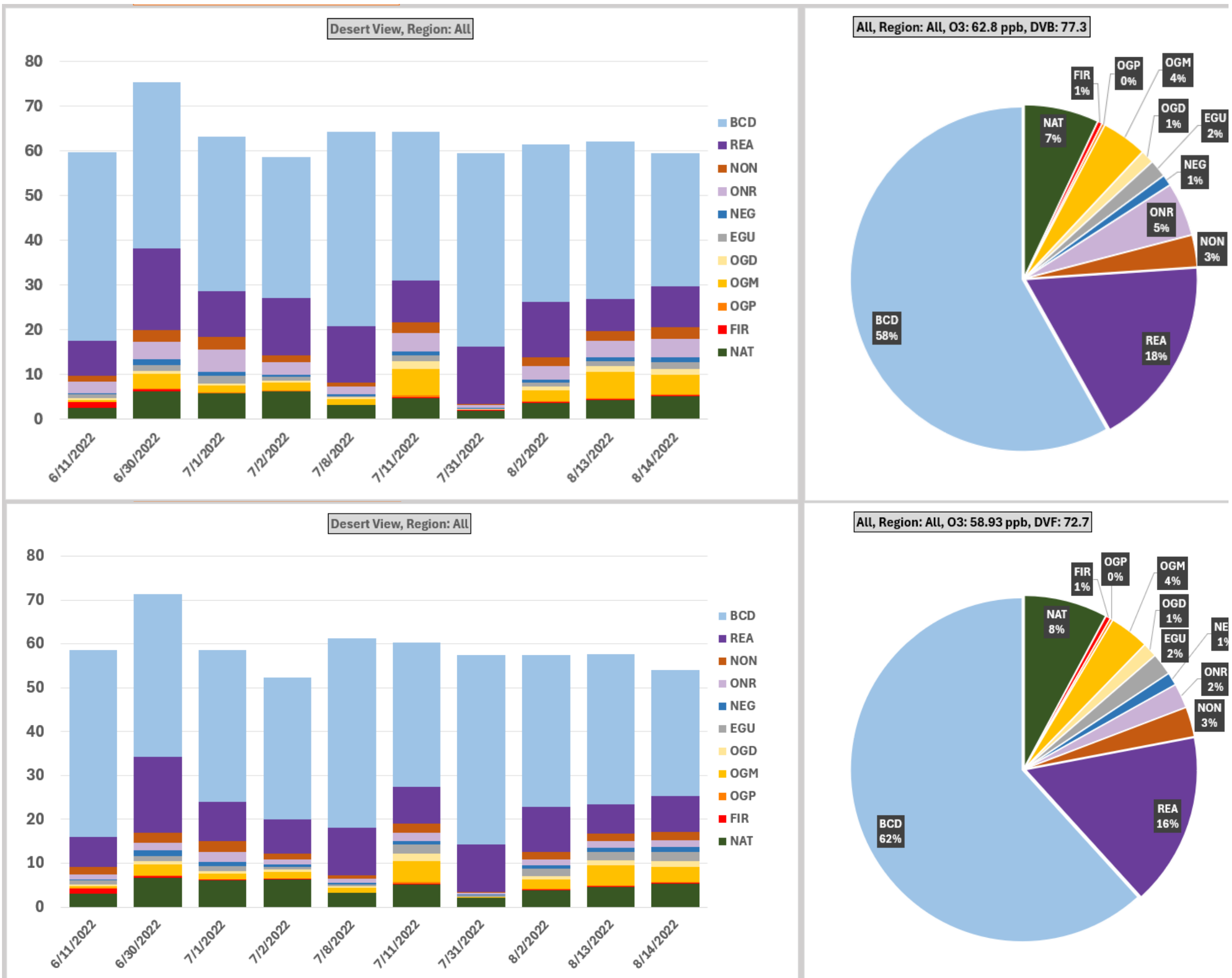

Figure 6-18. Desert View (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

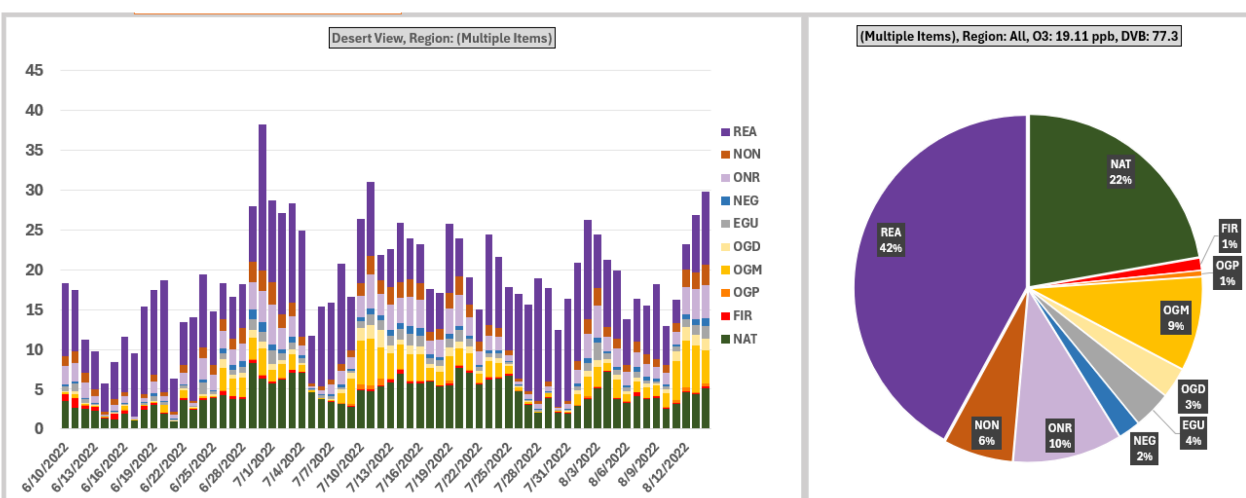

Figure 6-19. Source Category contributions to 2022 MDA8 ozone concentrations from all Source Regions and all days at the Desert View monitoring site in Doña Ana County.

6.2.4 2022 and 2032 Local Source Ozone Contributions at Central New Mexico Ozone Monitoring Sites

The Foot Hills monitoring site in Bernalillo County is used to illustrate ozone contributions at the Central New Mexico sites as it is the only site with a 2020-2024 ozone DVB that exceeds the 2015 ozone NAAQS (72.3 ppb). BCs for the average MDA8 ozone at Foot Hills monitor from the 10 SMAT days has a 70% (2022) and 74% (2032) contribution, which is higher than the sites discussed previously. This is due to Foot Hils having more SMAT days in the first half of June (Figure 6-20). The average MDA8 ozone across the 10 SMAT days is reduced 2.8 ppb from 2022 (61.6 ppb) to 2032 (58.8 ppb) that is primarily driven by reductions in on-road mobile (2.4 ppb).

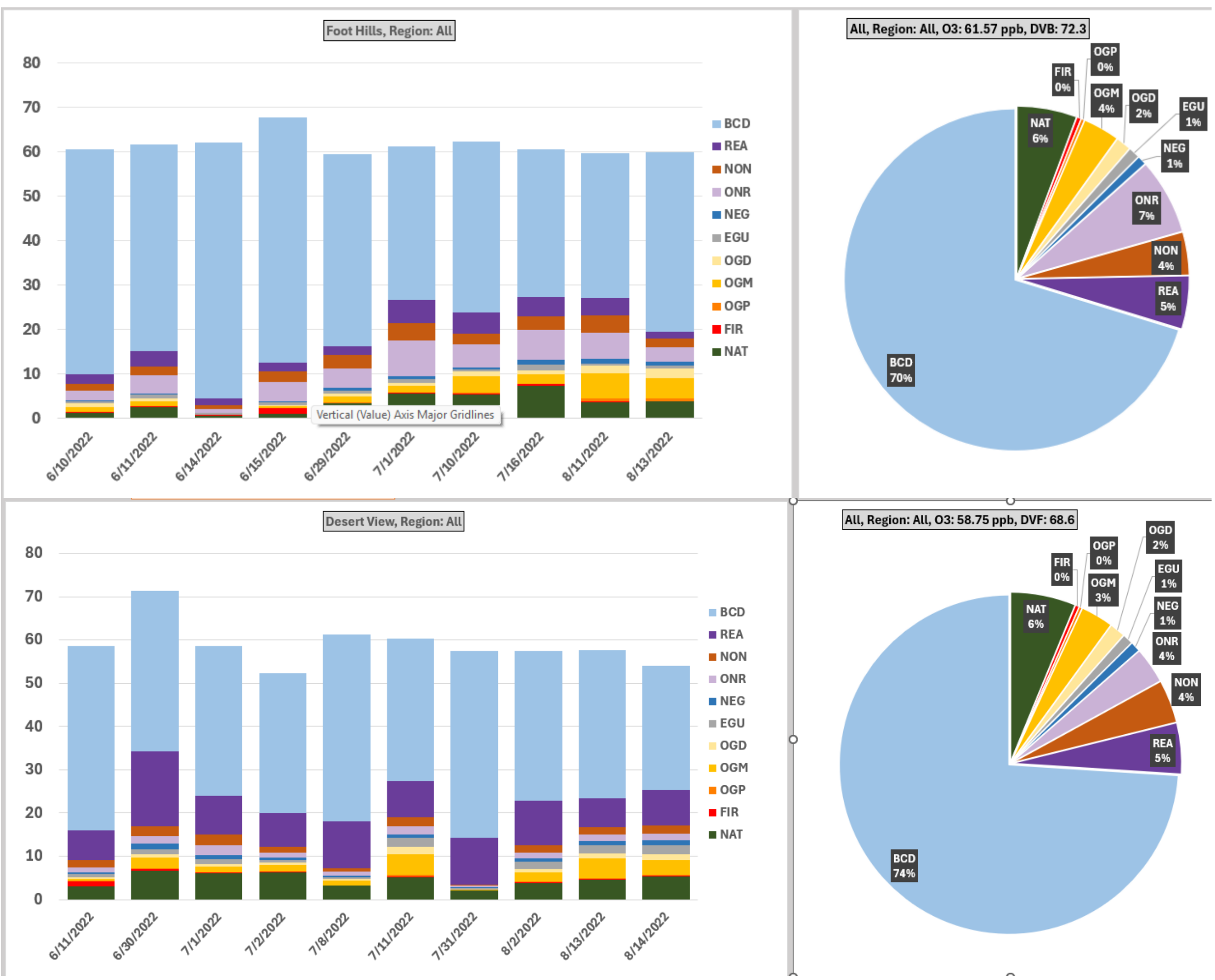

Figure 6-20. Foot Hills 2022 (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

The Source Category contributions to 2022 MDA8 ozone concentrations at Foot Hills across all days are shown in Figure 6-21. Remainder anthropogenic (included Mexico mobile) has the largest contribution on average (27%) followed by on-road (19%), O&G (15%), and non-road (12%). There are higher Source Category contributions starting in late June and continuing on most days through mid-August.

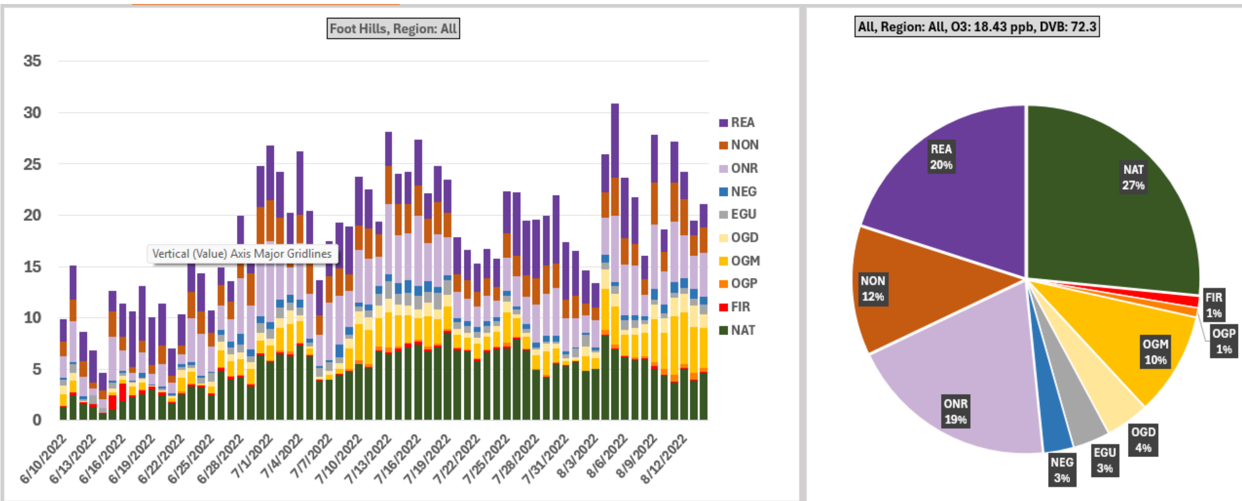

Figure 6-21. Source Category contributions to 2022 MDA8 ozone concentrations from all Source Regions and all days at the Foot Hills monitoring site in Bernalillo County.

6.2.5 2022 and 2032 Local Source Ozone Contributions at Northwest New Mexico Ozone Monitoring Sites

Ozone contributions at the Navajo Lake monitor in the South San Juan Basin in Northwest New Mexico that has a 2020-2024 ozone DVB of 69.3 ppb are discussed in this section. The Source Category ozone contributions to 2022 and 2032 MDA8 ozone concentrations on the 10 SMAT days at Navajo Lake are shown in Figure 6-22. As seen for the other sites, BCs contribute the most to the average 2022 (69%) and 2032 (72%) MDA8 ozone concentrations on the SMAT days at Navajo Lake. The average MDA8 concentration across the 10 SMAT days at Navajo Lake is reduced 2.7 ppb between 2022 and 2032 that is a combination of reductions from on-road (1.2 ppb), O&G (1.0 ppb) and EGU (0.5 ppb).

The Source Category contributions to 2022 MDA8 ozone concentrations at Navajo Lake for all days are shown in Figure 6-23. Across all days on average, O&G is the largest non-BC Source Category contributor (39%) to 2022 MDA8 ozone with O&G midstream being most important (24%). Natural is next most important (26%) followed by remainder anthropogenic (14%), on-road (11% and non-road (7%).

Figure 6-22. Navajo Lake 2022 (top) and 2032 (bottom) MDA8 ozone Dashboards for the 10 SMAT days and all Source Regions and Source Categories.

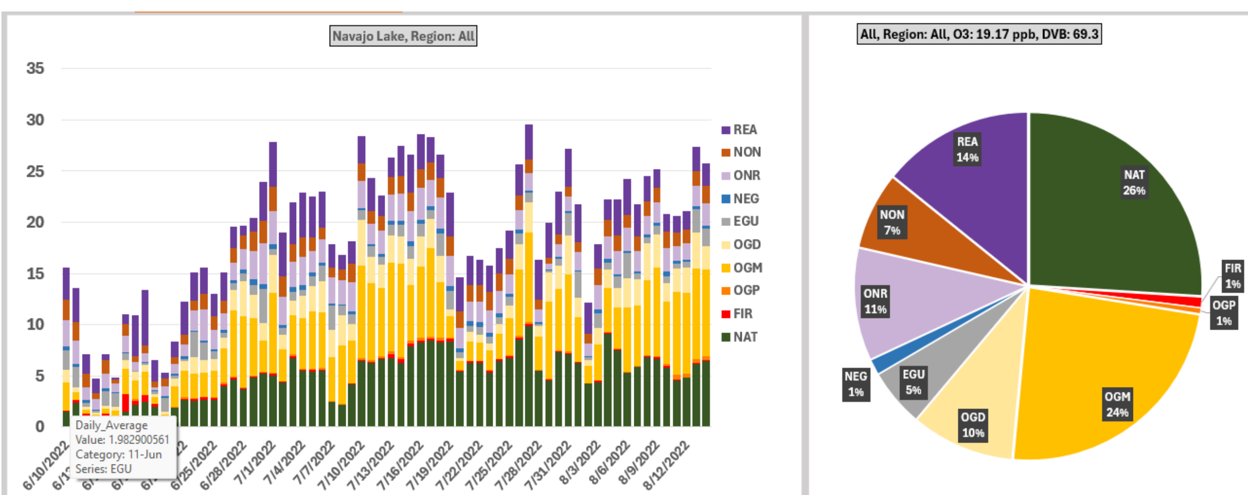

Figure 6-23. Source Category contributions to 2022 MDA8 ozone concentrations from all Source Regions and all days at the Navajo Lake monitoring site in San Juan County.

6.2.6 2022 and 2032 Ozone Contributions at Permian Basin Sites Accounting for Permian Basin O&G Emissions Underestimation

A 2022/2032 MDA8 ozone Local Source Dashboard was developed for the three New Mexico Permian Basin monitoring sites that had the same (Unadjusted) MDA8 ozone contributions as the standard Local Source Dashboard and with ozone contributions from the NMPB and TXPM O&G Source Groups adjusted upward to account for the ozone underestimation bias believed to be due to understated NMPB and TXPB O&G emissions with the adjustments to the Permian Basin O&G ozone contributions made the same two ways as the alternative 2032 ozone DVF projections were made using Local and Non-Local ozone increments:

> <u>Method 1 – Match Ozone DVB</u>: The NMPB and TXPB O&G ozone contributions are adjusted upward so that the average of the 2022 MDA8 ozone across the 10 SMAT days match the observed 2020-2024 ozone DVB.
>
> <u>Method 2 – Match Highest Observed MDA8 Ozone</u>: The NMPB and TXPB O&G ozone contributions are increased so that the average of the top 10 observed and modeled MDA8 ozone days (unmatched in time) are the same.

In both the alternative methods, the NMPB and TXPB O&G ozone contributions were increased by approximately a factor of 2. Below we show a couple examples from the 2022/2032 MDA8 ozone Permian Basin sites Dashboard.

Figure 6-24 display the 2022 MDA8 ozone contributions at Carlsbad City across the 10 SMAT days for all Source Groups. The only difference in the three approaches are the higher ozone contributions from NMPB and TXPB O&G for the two alternative methods, which results in lower relative contributions from the other Source Groups. For example, the Boundary Conditions (BCD) contribution that is 54% in the Unadjusted MDA8 ozone approach is reduced to 44% and 46% in the Method 1 and 2 approaches, respectively. The average across the 2022 MDA8 ozone concentrations for the 10 SMAT days that was 63.8 ppb in the Unadjusted approach so is lower than the 78 ppb 2020-2024 ozone DVB, is exactly 78.0 ppb in the Method 1 approach by design, with a slightly lower value in Method 2 (75.2 ppb).

Figure 6-25 displays the 2022 ozone contributions at Carlsbad City for days with MDA8 ozone greater than 65 ppb during June 10 to August 15 using the three approaches. There were 25 days during June 10 – August 15 with observed ozone concentrations greater than 65 ppb with an average across the 25 days of 72.2 ppb and peak value of 84.9 ppb. Using the Unadjusted ozone concentrations, there are only 4 days with MDA8 ozone greater than 65 ppb at Carlsbad City with an average value of 66.7 ppb and a peak value of 67.4 ppb (-21% below the peak observed MDA8 ozone). Using the Method 1 adjustment, there are 25 days with 2022 MDA8 ozone greater than 65 ppb with an average value of 73.0 ppb and peak value of 84.6 ppb (matching the observed peak). Method 2 has 21 days with MDA8 ozone greater than 65 ppb with an average of and peak of 81.1 ppb. Clearly the two methods that adjust upward the Permian Basin ozone contribution provide a much better match of the amount of elevated observed ozone concentration days at Carlsbad City.

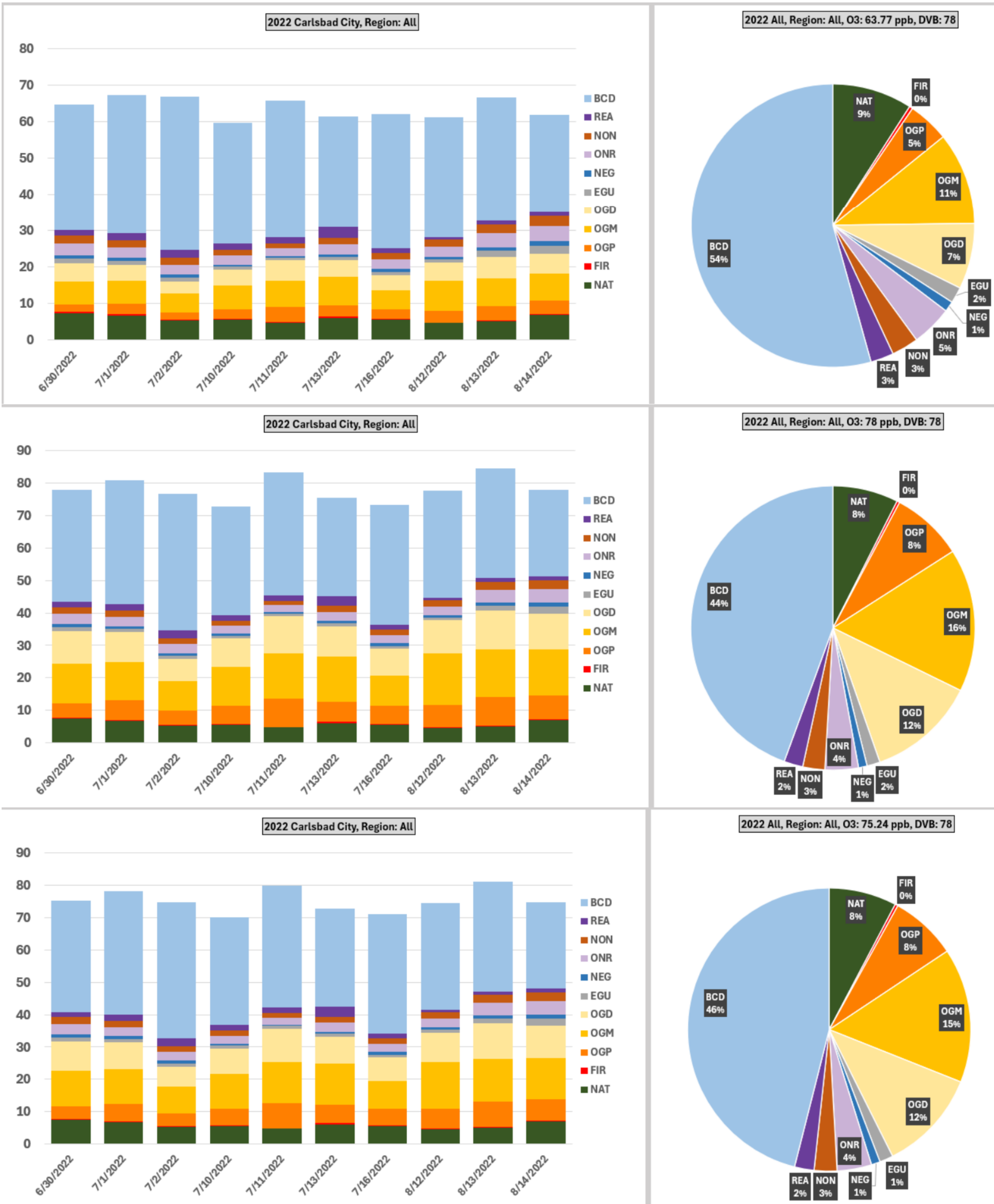

Figure 6-24. 2022 MDA8 ozone contributions at Carlsbad City across the 10 SMAT for unadjusted MDA8 ozone (top) and MDA8 ozone from NMPB and TXPB O&G Source Groups adjusted upward using Method 1 (middle) and Method 2 (bottom).

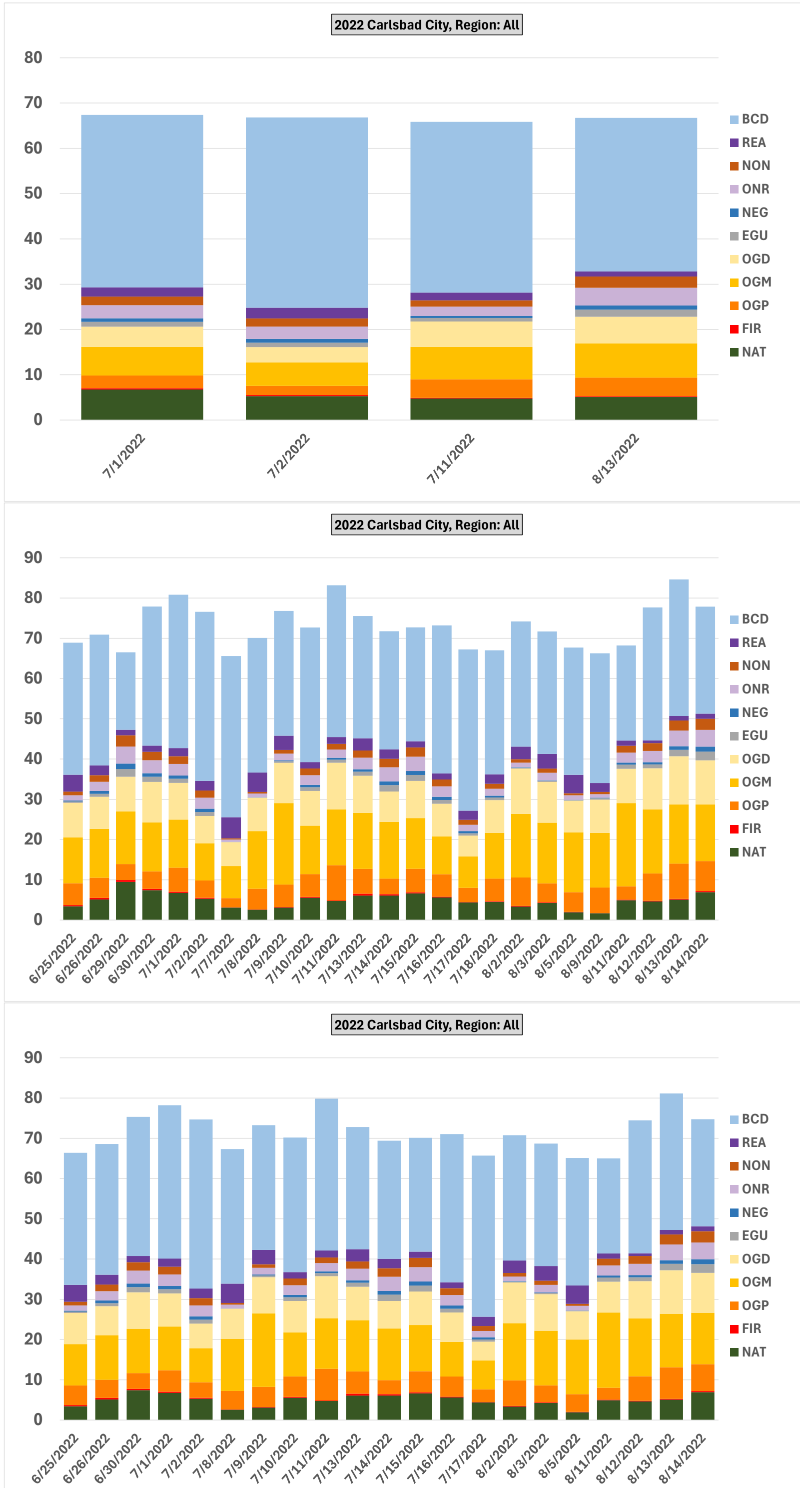

Figure 6-25. 2022 ozone contributions at Carlsbad City for MDA8 ozone days greater than 65 ppb during June 10 – August 15 and the Unadjusted ozone (top) and adjusted ozone using Method 1 (middle) and Method 2 (bottom).

7.0 CAMX 2032 STATE SPECIFIC OZONE SOURCE APPORTIONMENT MODELING

State Specific 2032 CAMx APCA ozone source apportionment modeling was conducted using the NMED CAMx 2022v2 12/4 km modeling platform. The CAMx 2032 state-specific ozone source apportionment obtained the contributions of anthropogenic emissions from 9 western states and from the Mexico portion of the 12/4 km domains to 2032 MDA8 ozone concentrations during the summer of 2022. The modeling was performed in a similar manner as EPA Good Neighbor Plan (GNP) for the 2015 ozone NAAQS with some notable exceptions:

- The GNP used the EPA CAMx 2016v3 12 km CONUS modeling platform.
- The GNP modeled state ozone contributions for the 2023 and 2026 years.
- The GNP obtained more refined mappings of state anthropogenic emissions treating all emissions as point sources, while the NMED CAMx 2032 state-specific modeling used a source region map that used grid cell definitions of states.
- The GNP obtained upwind state contributions to downwind state ozone Design Values using a Contribution Factor (CF) based on the modeled highest 10 2023 MDA8 ozone days, whereas the NMED CAMx 2032 state-specific used SMAT-CE to obtain contributions to 2032 Design Values that uses the modeled highest 10 MDA8 ozone days in 2022.

Due to time constraints of FY2026, only preliminary CAMx 2032 state-specific ozone source apportionment results are available at this time.

7.1 Contributions of Western States to New Mexico 2032 Ozone Design Values

The SMAT-CE Unmonitored Area Analysis (UAA) was used to generate spatial maps of contributions of western state anthropogenic emissions to projected 2032 ozone Design Values (DVFs) in the New Mexico 4 km domain. SMAT-CE UAA was first run with the CAMx 2022v2 base case and 2032 future year 4 km ozone output to obtain projected 2032 ozone DVFs across the New Mexico 4 km domain. SMAT-CE was then run with the 2022v2 4 km base case and CAMx 2032 ozone output with the contributions of a western state anthropogenic emissions removed to obtain the projected 2032 ozone DVF across the New Mexico 4 km domain without any anthropogenic emissions from the selected western state. The differences in the SMAT-CE 2032 ozone DVF projections with and without the contribution of the selected western state to the projected 2032 ozone DVF are displayed in spatial ozone concentrations maps.

The GNP used a 1% of the NAAQS as a significant contribution threshold to a projected ozone DVF at a nonattainment or maintenance receptor. EPA has also discussed using a 1.0 ppb ozone significant threshold, which is the same as the Significant Impact Level (SIL) used in Prevention of Significant Deterioration (PSD) permit modeling to show when a source's ozone contribution is "de minimis" and does not "cause or contribute to a violation of the NAAQS (EPA, 2018b). Note that the CAMx 2032 state-specific ozone source apportionment modeling is not a regulatory analysis and the 0.7 and 1.0 ppb thresholds are just used to assist in interpreting the modeling results.

Figure 7-1 displays the contribution of anthropogenic emissions from Arizona to the projected 2032 ozone DVF across the New Mexico 4 km domain. The maximum Arizona contribution is 2.5 ppb and occurs in Apache County, Arizona near the Springerville Generating Station. Arizona contributions in excess of 1.0 ppb occur in western New Mexico counties. Arizona contributions exceeding 0.7 ppb (i.e., yellow or warmer colors) occur over most of the western half of New Mexico. In the New Mexico portion of the El Paso-Las Cruces ozone nonattainment area, Arizona is contributing approximately 0.7 ppb. And in the New Mexico portion of the Permian Basin, Arizona is contributing 0.3 to 0.6 ppb to the projected 2032 ozone DVF.

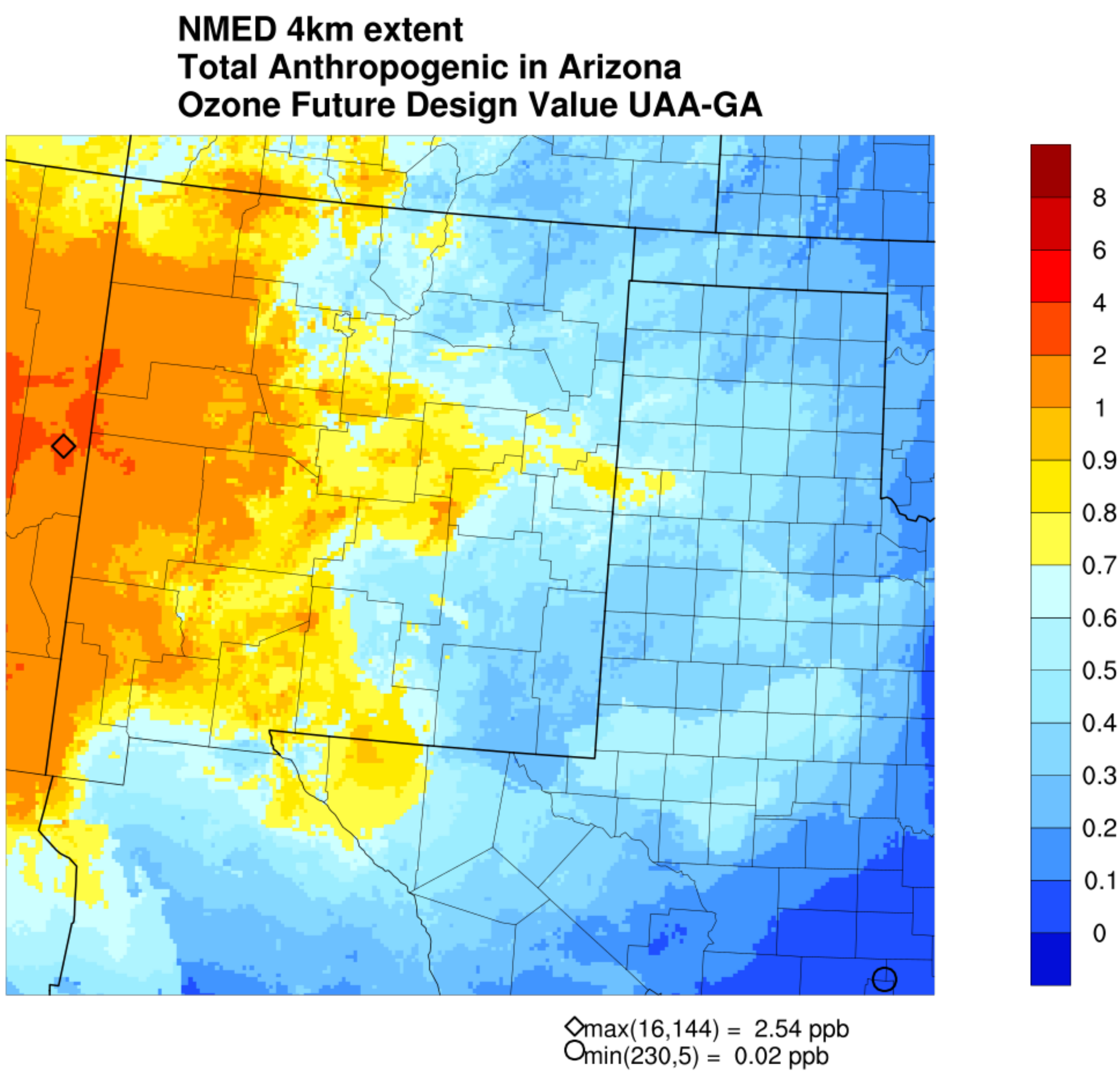

Figure 7-1. Contributions of anthropogenic emissions from Arizona to projected 2032 ozone DVFs in the New Mexico 4 km domain.

California contributes over 1.0 ppb to the projected 2033 ozone DVF in Rio Arriba and Taos Counties in northern New Mexico and a scattering of areas in northern New Mexico above 0.7 ppb (Figure 7-2). California contributed 0.2-0.3 ppb in southern Doña Ana County and the New Mexico portion of the Permian Basin.

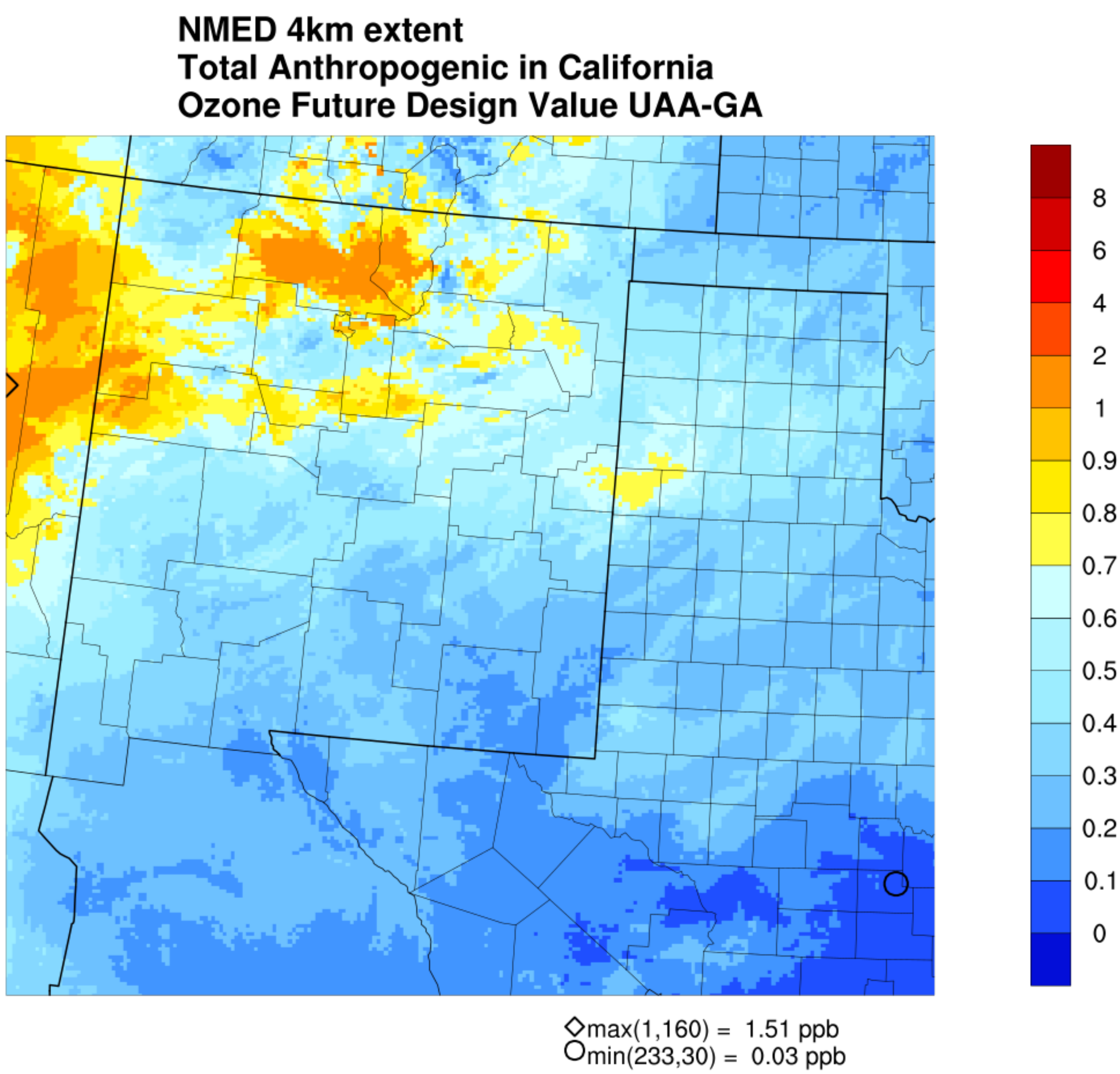

Figure 7-2. Contributions of anthropogenic emissions from California to projected 2032 ozone DVFs in the New Mexico 4 km domain.

The maximum contribution of Colorado to the projected 2032 ozone DVF in the New Mexico 4 km domain is 3.0 ppb and occurs in southern La Plata County, Colorado on the border with New Mexico (Figure 7-3). Surprisingly, the high Colorado contributions to 2032 ozone DVF do not transport very far into New Mexico with contributions of above 1.0 ppb just barely getting into the northern parts of San Juan and Rio Arriba Counties, New Mexico.

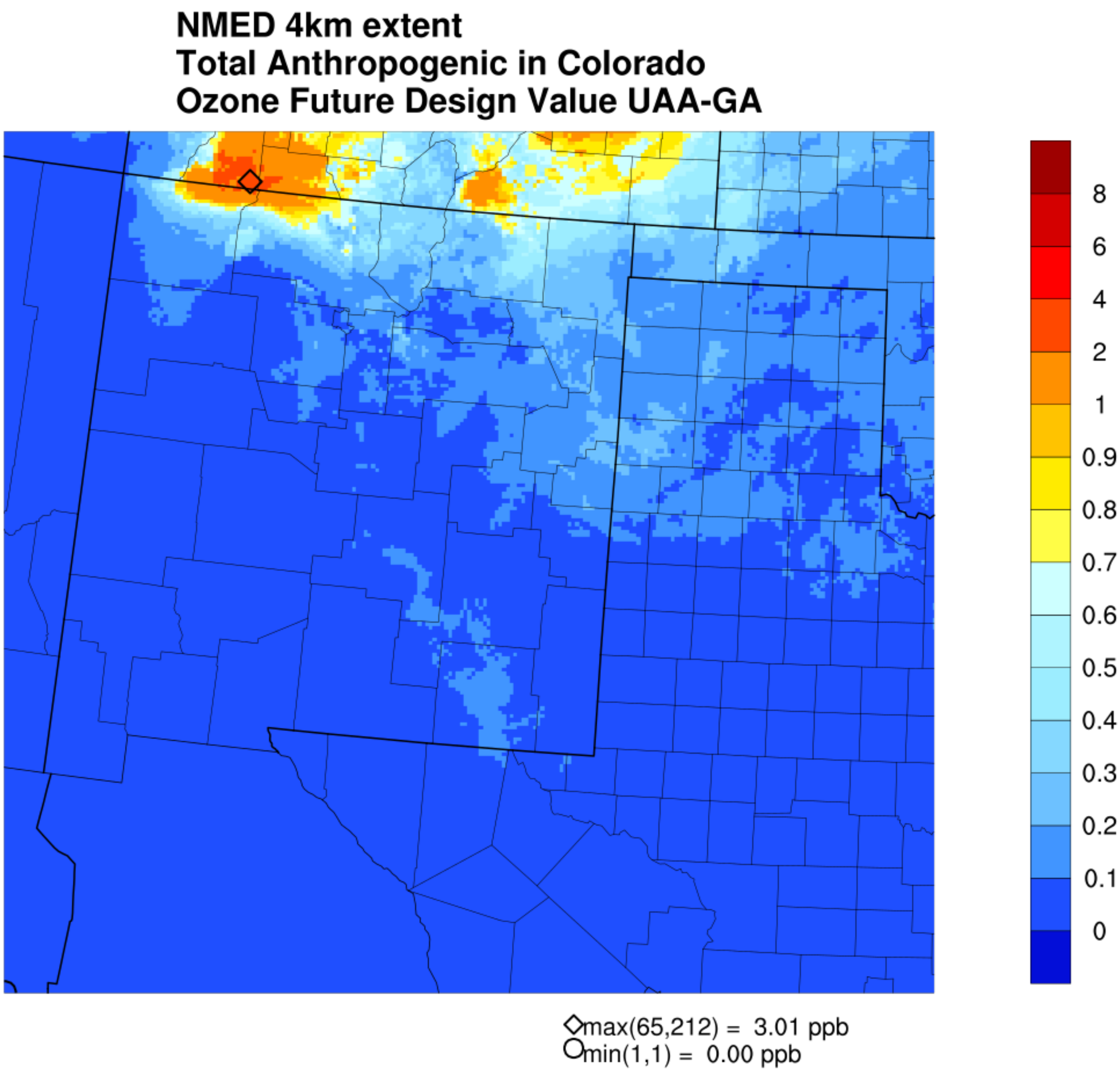

Figure 7-3. Contributions of anthropogenic emissions from Colorado to projected 2032 ozone DVFs in the New Mexico 4 km domain.

Kansas contributes as much as 2.4 ppb to the 2032 ozone DVF within Kansas (Figure 7-4). Kansas has almost no contribution (< 0.1 ppb) to the projected 2032 ozone DVF in New Mexico.

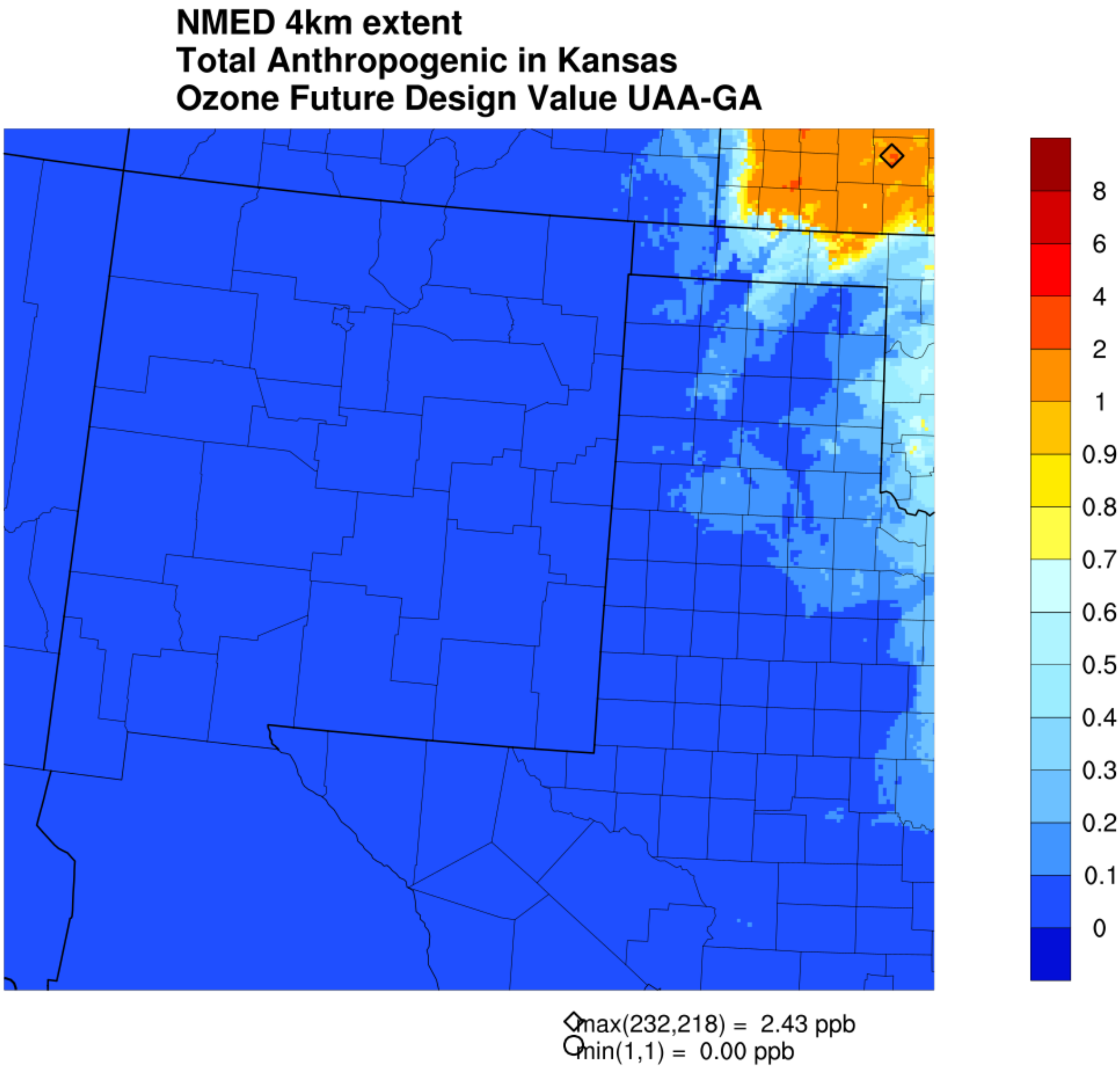

Figure 7-4. Contributions of anthropogenic emissions from Kansas to projected 2032 ozone DVFs in the New Mexico 4 km domain.

Nevada has some contributions in the 0.1-0.2 ppb range in scattered areas in northern New Mexico but most Nevada contribution to 2032 ozone DVFs across New Mexico are less than 0.1 ppb (Figure 7-5).

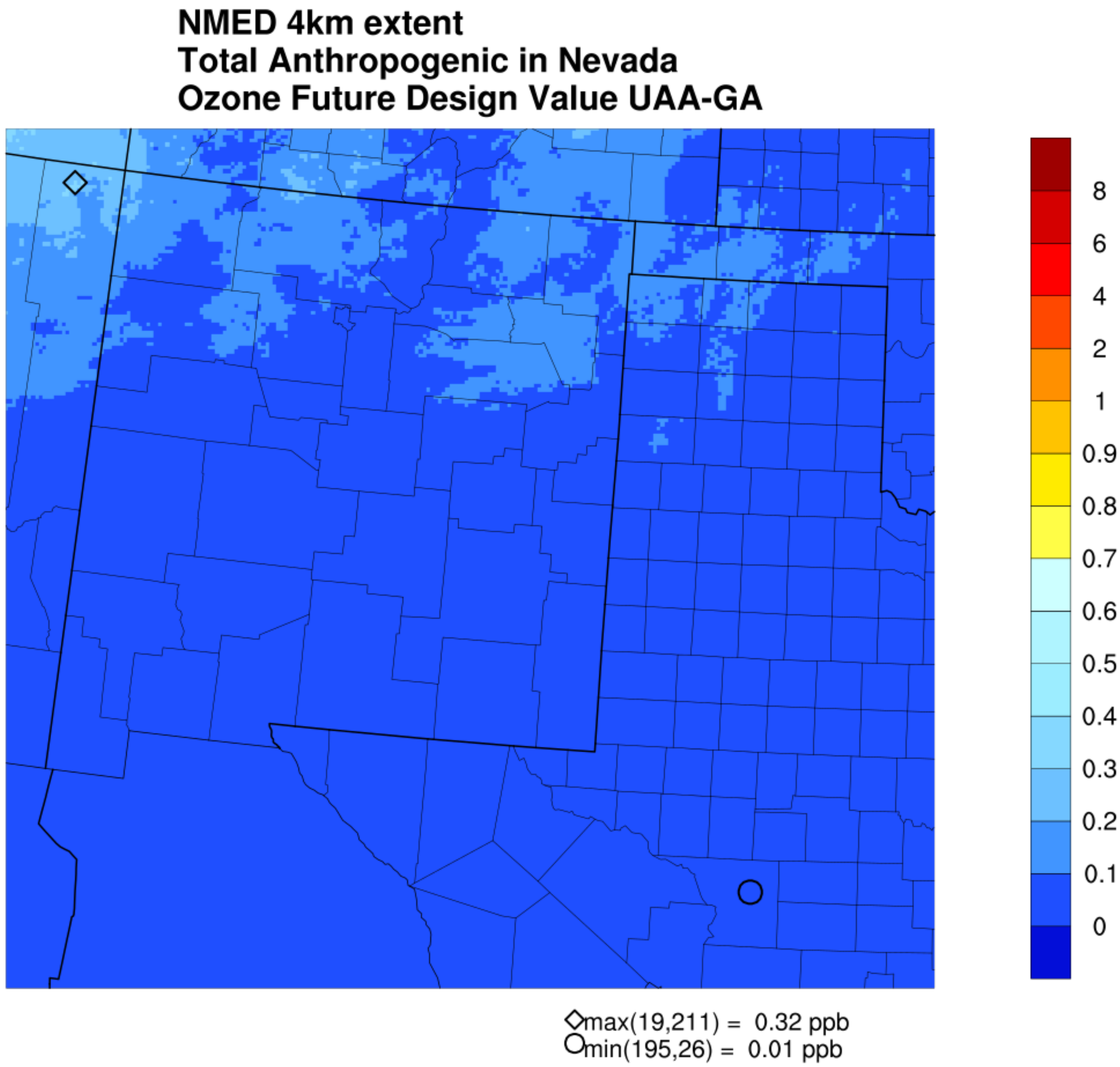

Figure 7-5. Contributions of anthropogenic emissions from Nevada to projected 2032 ozone DVFs in the New Mexico 4 km domain.

Oklahoma’s maximum 2032 DVF contribution in the New Mexico 4 km domain is 5.6 and occurs in Oklahoma (Figure 7-6). Oklahoma’s contribution across a vast majority of New Mexico is less than 0.1 ppb, although values of approximately 0.3 ppb contribute in the Permian Basin and southern Doña Ana County.

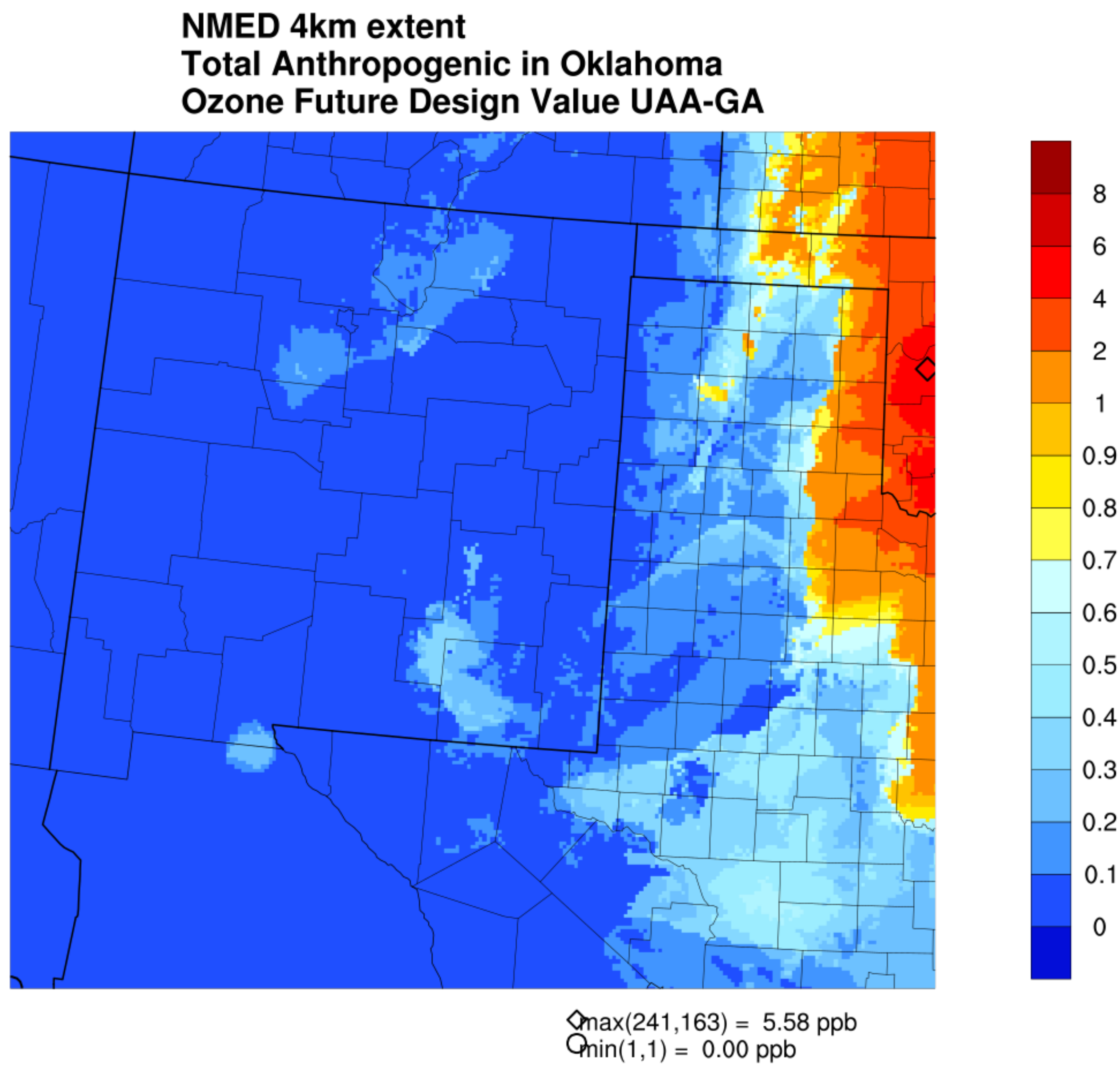

Figure 7-6. Contributions of anthropogenic emissions from Oklahoma to projected 2032 ozone DVFs in the New Mexico 4 km domain.

As seen in the CAMx 2022 and 2032 Local Source ozone source apportionment modeling discussed in Chapter 6, Texas has significant contributions to the projected 2032 ozone DVFs in Southern Doña Ana County and the Permian Basin portion of New Mexico where Texas contributions in excess of 4 ppb occur (Figure 7-7). In southern Doña Ana County (including the ozone NAA) and the New Mexico portion of the Permian Basin, the Texas ozone contribution exceeds 1.0 ppb over large portions of these two areas. There are also Texas contributions in excess of 1.0 ppb north of Albuquerque in Sandoval County.

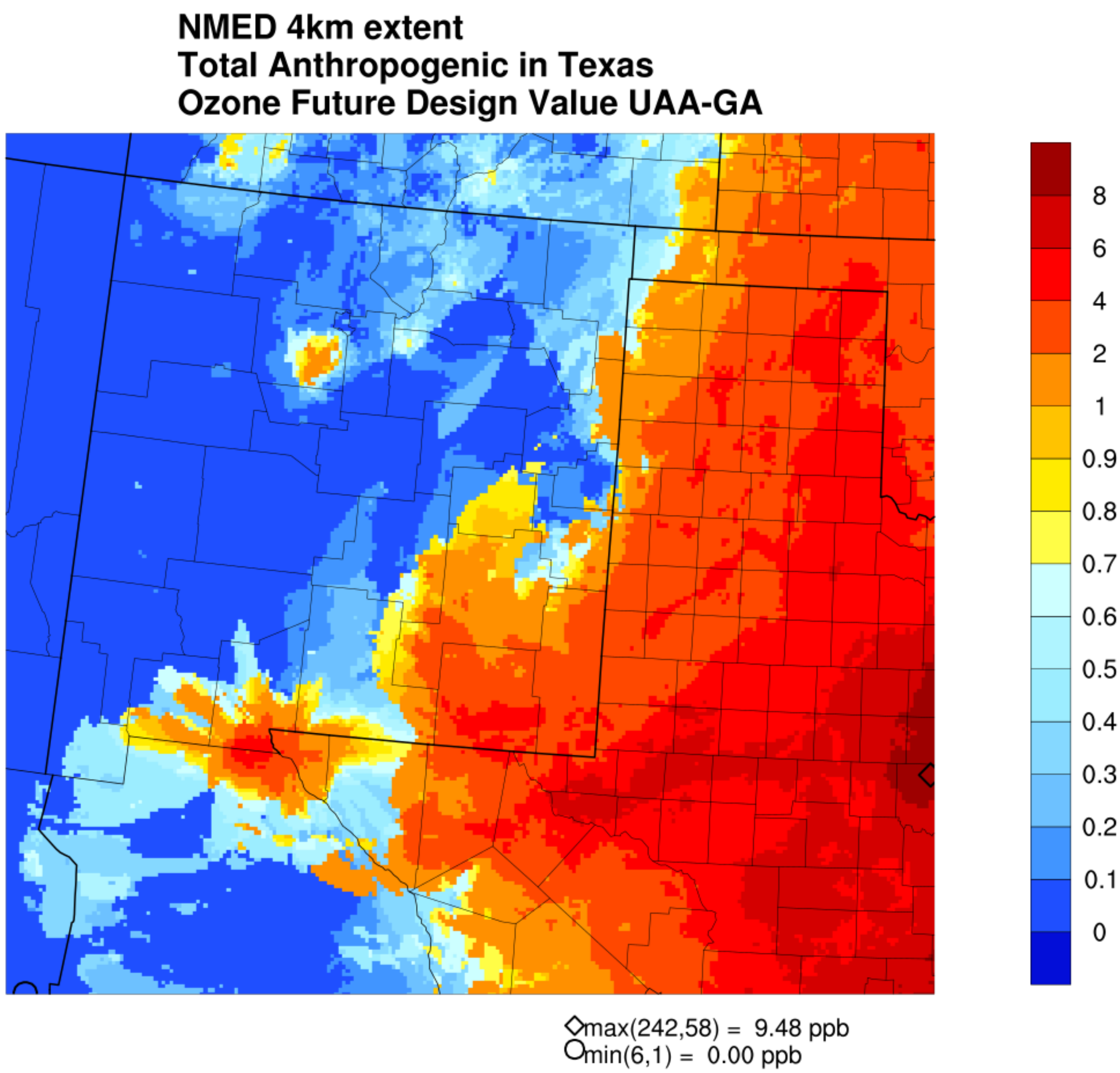

Figure 7-7. Contributions of anthropogenic emissions from Texas to projected 2032 ozone DVFs in the New Mexico 4 km domain.

Utah contributes very little (< 0.1 ppb) to 2032 ozone DVF in southern Doña Ana County and the Permian Basin in New Mexico (Figure 7-8). Utah contributions in the 0.4-0.5 ppb range occur in the northwest corner of New Mexico.

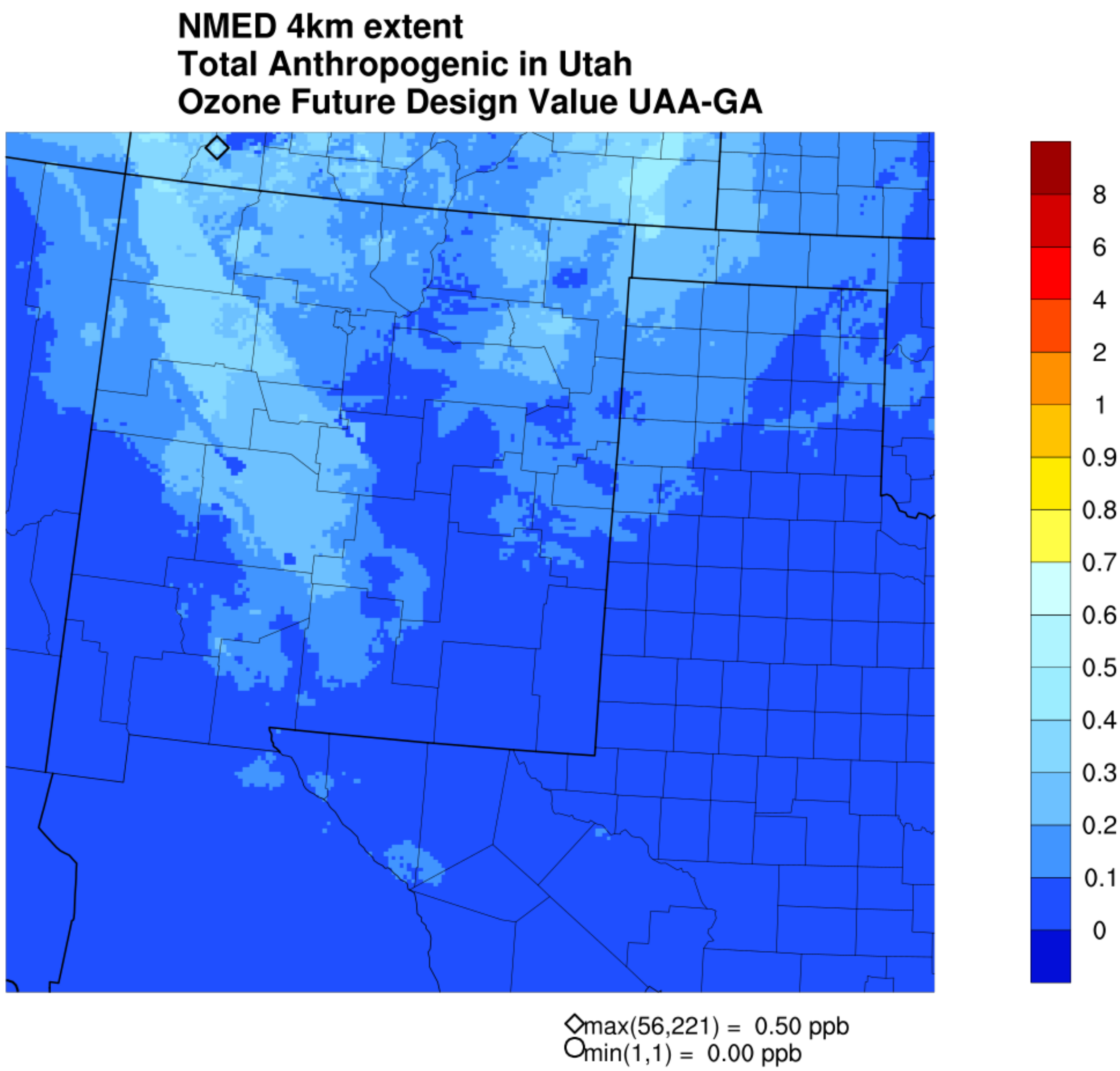

Figure 7-8. Contributions of anthropogenic emissions from Utah to projected 2032 ozone DVFs in the New Mexico 4 km domain.

7.2 Contributions of Mexico to New Mexico 2032 Ozone Design Values

Figure 7-9 displays the contributions of Mexico anthropogenic emissions that reside in the 12/4 km domains to the 2032 ozone DVFs. There are additional Mexico anthropogenic emissions contributions that enter through the Boundary Conditions (BCs) that could not be separated from background and natural emissions contributions that are also embedded in the BCs. With just the in-domain anthropogenic emissions, Mexico contributes over 1 ppb across the New Mexico portion of the Permian Basin and greater than 6 ppb in the NAA in southern Doña Ana County.

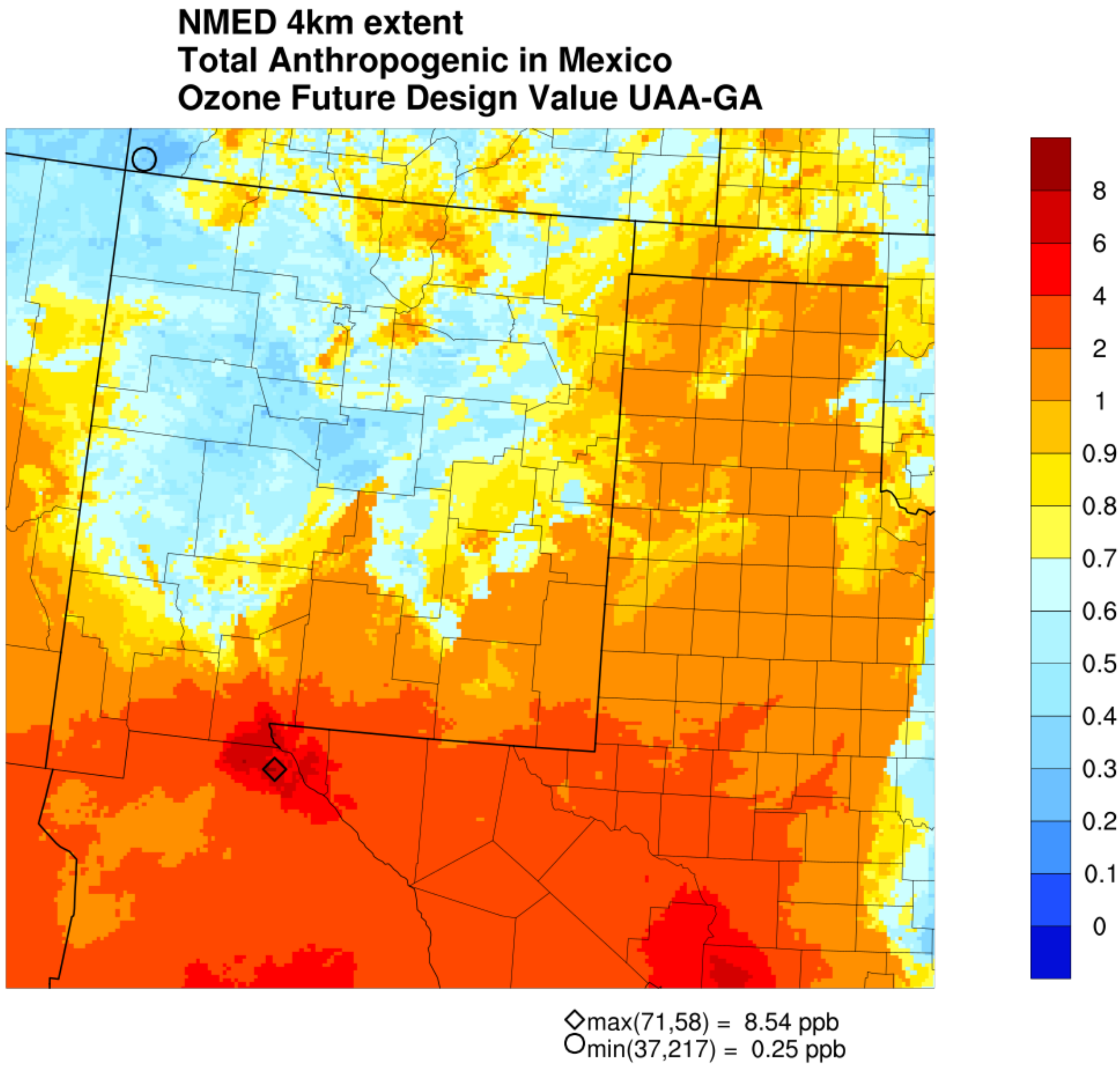

Figure 7-9. Contributions of anthropogenic emissions from Mexico within the 12/4 km modeling domain to projected 2032 ozone DVFs in the New Mexico 4 km domain.

Figure 7-10 displays the projected 2032 ozone DVFs across the New Mexico 4 km domain without the contributions of anthropogenic emissions from Mexico within the 12/4 km modeling domains. The maximum 2032 ozone DVF is 76.7 ppb and occurs in Eddy County in the New Mexico portion of the Permian Basin and is above the 2015 ozone NAAQS. Figure 7-10 does not eliminate the contributions of anthropogenic from Mexico or other international anthropogenic emissions that occur outside of the 12/4 km modeling domains that if excluded would lower the projected 2032 ozone DVFs across the New Mexico 4 km modeling domain.

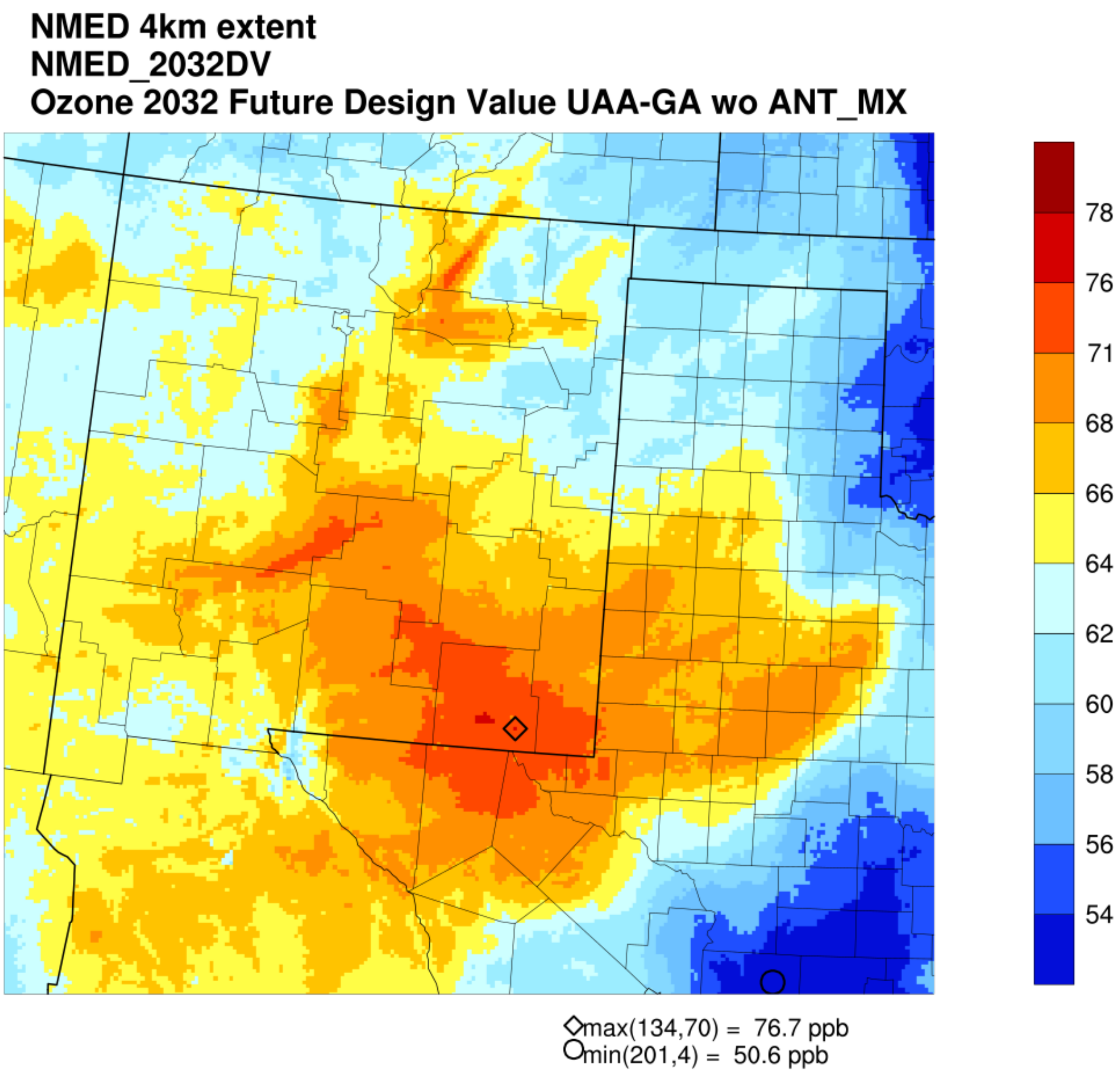

Figure 7-10. Projected 2032 ozone DVFs in the New Mexico 4 km domain without the contributions of Mexico anthropogenic emissions within the 12/4 km modeling domains.

7.3 Comparison of Western State 2032 and GNP 2023/2026 Contributions to Future Year Ozone DVFs

In this section we compare the contributions of western state anthropogenic emissions to the projected 2032 ozone DVFs shown in Figures 7-1 through 7-8 with their contributions to 2023 and 2026 ozone DVFs at New Mexico monitoring sites from the Good Neighbor Plan (GNP), which are shown in Tables 7-1 and 7-2. The GNP western state 2023/2026 DVF contributions are colored red if they exceed 1.0 ppb and yellow if they fall between 0.7 and 1.0 ppb.

For the GNP, Arizona contributes over 1.0 ppb to the 2023 ozone DVF at all sites in New Mexico except Santa Fe (0.95 ppb; Table 7-1) while the contributions to 2026 DVFs all exceed 0.7 ppb (Table 7-2). For the 2032 DVF projections (Figure 7-1), Arizona contributes over 0.7 ppb for approximately the western half of New Mexico with contributions exceeding 1.0 ppb for just a few of the most western New Mexico Counties. The lower Arizona 2032 ozone concentrations than contributions in 2023/2026 is expected given that there are lower NO_X and VOC emissions in 2032 (e.g., mobile source emissions continue to decline). The GNP has higher Arizona 2026 contributions to the New Mexico Permian Basin monitors (> 1.0 ppb) than in southern Doña Ana County (mostly ~0.9 ppb), whereas the Arizona contribution to the 2032 DVFs is relative higher in southern Doña Ana Conty than the Permian Basin. The reasons for this are not clear, but the 2026 projections (2016v3) and 2032 projections (2022v2) have two different years of meteorology that could be causing these differences.

Ther are similarities between the California contributions to 2023/2026 ozone DVFs from the GNP and this study's 2032 DVF contributions with both having higher contributions in northwest New Mexico (South San Juan Basin) and central New Mexico (e.g., Albuquerque). However, in the New Mexico portion of the Permian Basin, the GNP has some California 2023/2026 contributions that exceed 0.7 ppb, while the 2032 contributions are approximately half that (Figure 7-2).

For Colorado, both the GNP and this study (Figure 7-3) agree that the highest Colorado contributions that can exceed 1.0 ppb occur in the South San Juan Basin in northwest New Mexico with the Colorado contributions being much lower in the rest of New Mexico.

The GNP and this study agree that Kansas, Nevada, Oklahoma and Utah have fairly low contributions to future year ozone DVFs in New Mexico.

The two studies also have similar patterns of Texas contributions to future year DVFs with both studies estimate the highest contributions that exceed 1.0 ppb at the southern Doña Ana and Permian Basin sites, but also Texas contributions between 0.7 and 1.0 ppb in the Albuquerque area.

Table 7-1. Contributions of western states to projected 2023 ozone DVFs in New Mexico from the EPA Good Neighbor Plan for the 2015 ozone NAAQS.

Site ID	County		2023 Avg DV	2023 Max DV	AZ	CA	CO	KS	NV	OK	TX	UT	Canada & Mexico
350010023	Bernalillo	Del Norte	64.0	66.6	1.41	0.41	0.35	0.01	0.10	0.02	0.92	0.17	1.84
350010029	Bernalillo	South Valley	62.2	62.8	1.38	0.90	0.41	0.01	0.15	0.02	0.97	0.24	1.27
350011012	Bernalillo	Foot Hills	63.8	66.0	1.62	0.60	0.39	0.01	0.12	0.02	0.78	0.18	1.66
350130008	Dona Ana	La Union	65.6	66.3	1.13	0.44	0.12	0.05	0.06	0.12	3.83	0.08	10.77
350130020	Dona Ana	Chaparral	66.2	68.8	1.69	0.65	0.06	0.01	0.07	0.01	2.35	0.04	8.39
350130021	Dona Ana	Desert View	70.8	**72.1**	1.04	0.31	0.15	0.06	0.05	0.16	4.74	0.16	13.31
350130022	Dona Ana	Santa Teresa	69.7	**72.4**	1.06	0.31	0.18	0.05	0.05	0.14	3.59	0.15	12.87
350130023	Dona Ana	Solano	63.7	64.6	1.25	0.39	0.09	0.03	0.04	0.04	1.56	0.05	5.87
350151005	Eddy	Carlsbad Caverns	69.7	**74.1**	1.34	0.63	0.18	0.10	0.08	0.25	1.91	0.06	3.43
350153001	Eddy	Carlsbad City	70.2	70.2	1.51	0.97	0.09	0.00	0.19	0.00	1.38	0.21	4.17
350250008	Lea	Hobbs	69.8	**72.2**	1.66	0.71	0.08	0.01	0.10	0.01	2.17	0.10	3.81
350390026	Rio Arriba	Coyote	60.8	62.4	1.01	1.19	0.55	0.00	0.32	0.00	0.19	0.85	1.13
350431001	Sandoval	Bernalillo	62.4	64.6	1.29	0.62	0.34	0.01	0.12	0.02	1.01	0.14	1.81
350450009	San Juan	Bloomfield	60.4	64.2	1.16	1.34	0.91	0.00	0.29	0.00	0.46	0.58	1.26
350450018	San Juan	Navajo Lake	63.9	65.8	1.20	1.37	1.31	0.00	0.26	0.01	0.51	0.52	1.30
350451005	San Juan	Sub Station	59.1	62.8	1.72	1.09	0.84	0.00	0.20	0.01	0.50	0.53	1.32
350490021	Santa Fe	Santa Fe	61.1	63.0	0.93	0.81	0.51	0.01	0.12	0.02	0.67	0.15	1.52
350610008	Valencia	Los Lunas	62.3	63.9	1.46	0.93	0.39	0.01	0.16	0.02	0.97	0.23	1.33

Table 7-2. Contributions of western states to projected 2026 ozone DVFs in New Mexico from the EPA Good Neighbor Plan for the 2015 ozone NAAQS.

Site ID	County	Site	2026 Avg DV	2026 Max DV	AZ	CA	CO	KS	NV	OK	TX	UT	Canada & Mexico
350010023	Bernalillo	Del Norte	63.1	65.6	1.03	0.40	0.34	0.01	0.09	0.02	0.84	0.14	1.83
350010029	Bernalillo	South Valley	61.2	61.8	1.02	0.87	0.39	0.01	0.13	0.02	0.90	0.20	1.26
350011012	Bernalillo	Foot Hills	62.9	65.0	1.19	0.59	0.38	0.01	0.11	0.02	0.71	0.16	1.66
350130008	Dona Ana	La Union	64.8	65.5	0.88	0.43	0.12	0.05	0.05	0.11	3.39	0.06	10.87
350130020	Dona Ana	Chaparral	65.3	67.9	1.33	0.63	0.05	0.00	0.06	0.01	2.07	0.03	8.43
350130021	Dona Ana	Desert View	69.9	**71.2**	0.82	0.30	0.14	0.06	0.04	0.14	4.34	0.14	13.43
350130022	Dona Ana	Santa Teresa	69.0	**71.6**	0.82	0.31	0.17	0.05	0.04	0.13	3.23	0.13	12.98
350130023	Dona Ana	Solano	62.8	63.7	0.99	0.38	0.08	0.03	0.03	0.04	1.37	0.03	5.89
350151005	Eddy	Carlsbad Caverns	69.1	**73.4**	1.06	0.62	0.17	0.09	0.07	0.24	1.81	0.04	3.42
350153001	Eddy	Carlsbad City	69.6	69.6	1.21	0.96	0.09	0.00	0.16	0.00	1.28	0.15	4.17
350250008	Lea	Hobbs	69.2	**71.6**	1.34	0.70	0.08	0.01	0.09	0.01	2.10	0.07	3.80
350390026	Rio Arriba	Coyote	60.4	61.9	0.75	1.17	0.54	0.00	0.27	0.00	0.17	0.70	1.12
350431001	Sandoval	Bernalillo	61.5	63.7	0.94	0.61	0.32	0.01	0.10	0.02	0.93	0.12	1.81
350450009	San Juan	Bloomfield	59.8	63.5	0.84	1.31	0.90	0.00	0.23	0.00	0.44	0.48	1.26
350450018	San Juan	Navajo Lake	63.3	65.2	0.88	1.34	1.29	0.00	0.21	0.01	0.48	0.44	1.30
350451005	San Juan	Sub Station	58.4	62.0	1.32	1.07	0.84	0.00	0.16	0.01	0.46	0.45	1.31
350490021	Santa Fe	Santa Fe	60.5	62.4	0.72	0.80	0.50	0.01	0.11	0.02	0.59	0.12	1.50
350610008	Valencia	Los Lunas	61.5	63.1	1.07	0.91	0.38	0.01	0.14	0.02	0.90	0.20	1.33

8.0 REFERENCES

BLM. 2024. BLM Air Resources Technical Report for Oil and Gas Development in New Mexico, Oklahoma, Texas and Kansas. U.S. Department of the Interior, Bureau of Land Management. https://www.blm.gov/sites/default/files/docs/2025-12/air-resources-technical-report-nm-2024.pdf

Dunker, A.M., B. Koo and G. Yarwood. 2019. Standard and Alternative Procedures for Projection Future Year Ozone in the Houston Area using Relative Reduction Factors. *Atmos. Env*., Vol 2, April 2019. https://www.sciencedirect.com/science/article/pii/S2590162119300322?via%3Dihub

Emery, C.E., Z. Liu, A.G. Russell, M.T. Odman, G. Yarwood and N. Kumar. 2017. Recommendations on statistics and benchmarks to assess photochemical model performance. J. of the Air and Waste Management Assoc., Vol. 67, Issue 5. DOI: 10.1080/10962247.2016.1265027. https://www.tandfonline.com/doi/full/10.1080/10962247.2016.1265027

EPA. 2018a. Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze. US Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division (EPA 454/R-18-009, November 2018). https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.

EPA. 2018b. Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. Peter Tsirigotis, Director, Office of Air Quality Planning and Standards, Research Triangle Park, NC. April 17. https://www.epa.gov/sites/default/files/2018-04/documents/sils_policy_guidance_document_final_signed_4-17-18.pdf

EPA. 2023. 2020 National Emission Inventory Technical Support Document. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-neitechnical-support-document-tsd

EPA. 2025a. Technical Support Document (TSD) Preparation of Emissions Inventories for the 2022v1 North American Emissions Modeling Platform. U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC. EPA-454/B-25-001. May. https://www.epa.gov/system/files/documents/2025-12/2022v1_emismod_tsd_base_and_2026_may2025_508.pdf

EPA. 2025b. Technical Support Document (TSD) Preparation of Emissions Inventories for the 2022v2 North American Emissions Modeling Platform. U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC. EPA-454/B-25-002. December. https://www.epa.gov/system/files/documents/2025-12/2022v2_emismod_tsd_base_december2025.pdf

Ramboll. 2016. Southern New Mexico Ozone Study – Technical support Document. Ramboll, Novato, California. October 19.

Ramboll. 2018. CRC Project Report No. A-112, Realtive Reduction Factors Using Anthropogenic Ozone Increments. Coordinating Research Council, Alpharetta, GA. Prepared by Ramboll, Novato, CA. October. https://crcao.org/wp-content/uploads/2019/05/CRC_A-112_Executive-Summary_22Oct18-1.pdf

Ramboll and WESTAR. 2020. New Mexico Ozone Attainment Initiative Photochemical Modeling Study – Draft Modeling Protocol. Ramboll, Novato, CA. May. https://westar.org/wp-content/uploads/2022/09/NM_OAI_Modeling_Protocol_v5.pdf

Ramboll and WESTAR. 2021a. Addendum Report - New Mexico Ozone Attainment Initiative Study – Revised 2014v2 Base Case and Model Performance Evaluation. Ramboll, Novato, CA. February. https://westar.org/wp-content/uploads/2022/09/NM_OAI_Addendum_2014v2_MPE_v2.pdf

Ramboll and WESTAR. 2021b. New Mexico Ozone Attainment Initiative Photochemical Modeling Study – Air Quality Technical Support Document. Ramboll, Novato, CA. May.

Ramboll. 2024. User's Guide Comprehensive Air quality Model with extensions – Version 7.30. Ramboll Environment and Health, Novato, California. June. https://www.camx.com/Files/CAMxUsersGuide_v7.30.pdf

Ramboll. 2025a. 2026 Ozone Source Apportionment Modeling for the Permian Basin using the 2022v1 Modeling Platform – Draft Work Plan. Ramboll, Novato, California. April.

Ramboll. 2025b. 2026 Ozone Source Apportionment Modeling for the Permian Basin using the 2022v1 Modeling Platform – 2022v1 Model Evaluation and 2026v1 Source Apportionment Results. Ramboll, Novato, California. June.

Ramboll. 2025c. WRF 2022 4 km Modeling for New Mexico and Model Performance Evaluation. Ramboll, Novato, California. June.

Ramboll. 2025d. Preliminary CAMx 2022 4 km Ozone Model Performance Evaluation Using New WRF 2922 4 km Meteorological Inputs. Ramboll, Novato, California. June.

Ramboll. 2026a. Conceptual Model of Ozone Formation in New Mexico with a Focus on the Permian Basin. Ramboll, Novato, California. January.

Ramboll. 2026b. Ozone Source Apportionment Modeling for New Mexico Environmental Department – 2022 and 2032 Ozone Source Apportionment Modeling using a CAMx 2022v2 12/4 km Modeling Platform – Draft